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THE SALAMANDERS OF THE FAMILY HYNOBIIDAE.

BY EMMETT REID DUNN.

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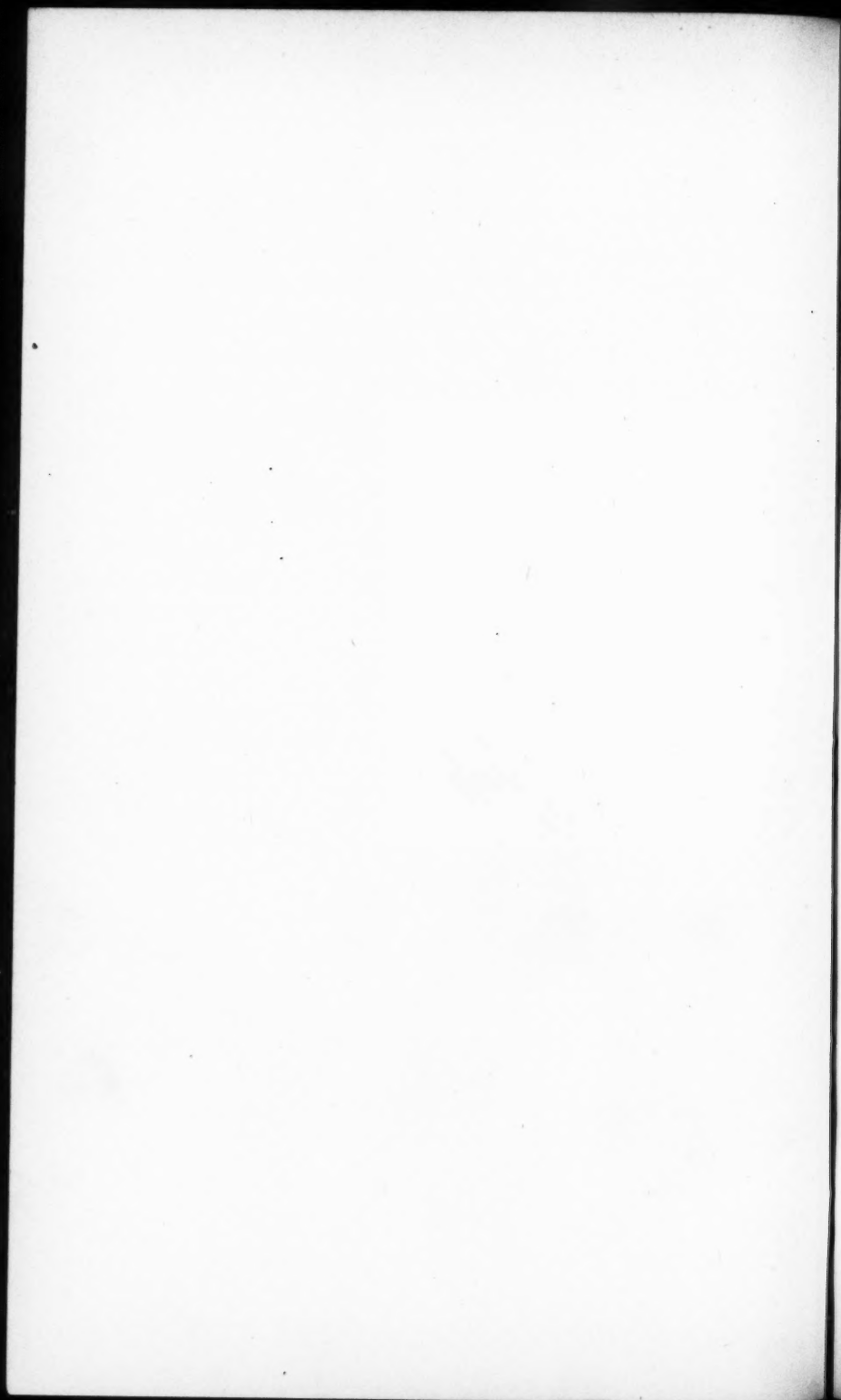
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THE SALAMANDERS OF THE FAMILY HYNOBIIDAE.

BY EMMETT REID DUNN.



## THE SALAMANDERS OF THE FAMILY HYNOBIIDAE.<sup>1</sup>

BY EMMETT REID DUNN.

Received January 29, 1923.

Presented by Thomas Barbour.

THE Salamander family *Hynobiidae* is a group of some five genera and twenty-one species. They are animals of northern Asia, the Urals and the mountains of Sze-chuan marking their extreme outposts to the West and to the South. A species of one of the genera (*Ranodon olympicus* Gaige) has been recorded from North America, but I have shown that this animal is not a *Ranodon*, and should be considered as the type of a distinct genus *Rhyacotriton*, which belongs to the *Ambystomidae*, and is most closely related to the genus *Dicamptodon*. (Proc. New England Zool. Club, VII, p. 55, 1920).

The relationships of the family are with the large river-salamanders, the *Cryptobranchidae*. If the *Hynobiidae* are not directly ancestral to these, at least they represent very well the less modified type from which such flattened, aquatic forms must have arisen. That the *Cryptobranchidae* are known from as far back as the Oligocene compels us to assume a still earlier era as the time of origin of the *Hynobiidae*. The characters on which this relationship is based serve also to distinguish between the *Hynobiidae-Cryptobranchidae* on the one hand and the remaining groups of salamanders on the other. To express this relationship I have proposed the superfamily name *Cryptobranchoidea*. (Amer. Nat. LVI, p. 418, 1922). These are certainly not derived from any existing group of salamanders, nor is it possible to point out any groups descended from them.

From a phylogenetic standpoint *Hynobius* occupies a central position, the other four genera showing various secondary modifications.

Within the genus *Hynobius* itself the Korean form, *H. leechii*, apparently represents the stock from which the other forms have descended. The other continental species, *chinensis*, *turkestanicus*, and *keyserlingii*, each bear marks of specialization. These four forms occupy separate areas. To the eastward, however, in the islands, the situation is more complex, as many as four forms of *Hynobius* occurring on Hondo.

The species of Sakhalin, *Hynobius cristatus*, seems to have been derived from *keyserlingii* of the opposite mainland.

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<sup>1</sup> Contributions from the Department of Zoology, Smith College, No. 105.

On Hondo, *peropus* of the high interior is very similar to the Korean *H. leechii*, while the very specialized form on Yezo, *retardatus*, has evident affinities with *peropus*. These two may well be the oldest *Hynobius* stock of Japan, as none of the other groups have reached Yezo.

A rather isolated group, (*stejnegeri* of Kiusiu, *kimurai* of Hondo, and *naevius* of Hondo and Shikoku), has affinities remotely with *leechii* rather than with any of the other Japanese forms, and may represent another invasion. The Formosan species, *sonani*, is much like *naevius*. It may be a member of the *naevius* group, or the likeness may be parallelism. Indeed this series of four species may have come from some mainland form rather different from *leechii*.

A third group, the animals of the islands in the Korean straits, connects *leechii* with *nebulosus* of Kiusiu, with *vandenburghi* of Hondo, and with the as yet undescribed form from Shikoku. Apparently this group represents the most recent invasion.

*Pachypalaminus boulengeri*, is, save for its peculiar feet, very like *Hynobius vandenburghi* of the same general region. This may be taken in the absence of other evidence to indicate genetic relationship.

*Batrachuperus sinensis* has the same foot modification, and what are essentially weakened prevomers, and weakened vomerine dentition. It has probably arisen from some form of *Hynobius*, many of its characters, as color, loss of the fifth toe, and development of the labial folds, suggesting *H. keyserlingii*.

*Ranodon sibiricus* has the same dentition as *Batrachuperus* but none of the other characters of that animal. It has probably arisen independently from some species of *Hynobius*. *H. turkestanicus*, as the only *Hynobius* of that region, may be the closest relative.

*Onychodactylus*, with two closely allied species, is developed for mountain brook life, and the lungs have disappeared. The prevomers are shortened, and larvae and breeding adults have claws. Otherwise it is not very different from *Hynobius*, from some species of which it has doubtless arisen. No modern species of *Hynobius*, however, is at all close to *Onychodactylus*.

The course of evolution of the family has been about as follows: The primitive stock was a series of essentially similar species spread over northern Asia. Owing, perhaps, to different immigrations, either in space, or in time, or in both, more than one form of *Hynobius* is found in Hondo, in Shikoku, and in Kiusiu. From this series of essentially similar species modified forms have arisen in several places, (Semirychensk, Sze-chuan, Ussuri, Hondo). All these modified

forms seem adapted to a more aquatic mode of life. A similar process in the more remote past produced the *Cryptobranchidae*.

Owing, perhaps, to their dependence on external fertilization, this group seems never to have produced forms adapted to a less aquatic mode of life. In this the *Hynobiidae* offer a great contrast to the *Plethodontidae* in which all the forms practise internal fertilization, and in which many or most of the species are terrestrial.

From a geographic standpoint the inferences to be drawn from the distribution of the *Hynobiidae* are: that Sakhalin has been connected with the mainland rather than with Yezo; that the Tsugaru Strait is of great age, Yezo having been separated from Hondo for considerable time; that the other islands of Japan have been connected with each other and with Korea both before and after the separation of Yezo; and that the present Korean Strait is of recent age.

Before embarking upon a systematic survey of the family it may be well to review briefly the significant features of the anatomy and the variations thereof.

The prearticular bone is distinct in the lower jaw of *Hynobiidae* and *Cryptobranchidae* and fused with the angular in the jaw of all other salamanders. Larvae of *Onychodactylus fischeri* have a horny edge on the dentary as well as teeth. This structure is seen elsewhere among salamanders only on the dentary of the *Sirenidae*.

A free lachrymal, extending from the orbit to the naris, is a feature of all Hynobiid skulls examined by me. (*B. sinensis*, *O. fischeri*, *H. leechii*, *H. peropus*, *H. kimurai*, *H. retardatus*, *H. vandenburghi*). Wiedersheim figures a lachrymal in *R. sibiricus* and in *H. naevius* and mentions its presence in *H. keyserlingii*. But Schlegel figures *H. naevius* as without a lachrymal and depicts a similar condition in *O. japonicus*, while Okajima failed to find a lachrymal in the latter animal. I can only comment that the bone is hard to see at times, being overlapped by both maxilla and nasal, and underlaid by the prefrontal.

In both *Hynobiidae* and *Cryptobranchidae* the nasals meet in the middorsal line and the nasal spines of the premaxillae are very short. This is in decided contrast to the condition of these elements in *Ambystomidae*, *Salamandridae*, and *Plethodontidae*, where the nasals are nearly always separated by the long spines of the premaxillae. A large premaxillary fontanelle is present in *Onychodactylus*: a smaller one in *Pachypalaminus*, according to a sketch kindly furnished me by Dr. Van Denburgh; and small ones are found in *Batrachuperus*, and, according to Wiedersheim's figure, in *Ranodon*. Except in young *H.*

*retardatus* this fontanelle is absent in *Hynobius* and in the *Cryptobranchidae*.

The prevomers of *Hynobius*, *Pachypalaminus*, and *Onychodactylus* are broadly in contact on the median line, and extend to a greater or less extent posteriorly. The dentition consists of a short outer branch, curving forward and in, and a longer inner branch extending backward and inward.

The length of this inner branch depends upon the length of the prevomer. Both bone and tooth row are shortest in *Onychodactylus*. In *Batrachuperus*, where the prevomers do not meet on the median line, the inner branch is absent, and apparently the same condition is found in *Ranodon*.

Both columella and operculum are present and free in *Hynobius leechii*. The *Cryptobranchidae*, and probably *Ranodon* and *Onychodactylus* as well, lack the operculum.

The hyobranchial apparatus of the family agrees with that of the *Cryptobranchidae* in having the ceratobranchial and epibranchial of the first arch fused into a cartilaginous rod, and in having the ceratobranchial and epibranchial of the second arch present and free. The *Salamandroidea* (*Ambystomidae*, *Salamandridae*, and *Plethodontidae*), have the elements of the first arch usually separate, and always lack the epibranchial of the second arch.

No family characters have yet been observed in vertebrae of salamanders but I think it worth while to mention the complete agreement of vertebrae of *Cryptobranchus*, *Onychodactylus*, and *Hynobius*, and the fact that no such agreement is found on comparison with vertebrae of *Ambystoma*, of *Triturus*, or of *Desmognathus*.

The ribs of *Hynobius*, of *Onychodactylus*, and of *Cryptobranchus* are widened proximally, but are not forked. Ribs of *Salamandroidea* are forked.

The number of costal grooves varies from eleven to fifteen, thirteen being the usual number. Individual variation in number amounts to two or three costal grooves.

Occasional specimens of *Ranodon* and of some *Hynobius* have a lateral fold of skin between the insertions of the legs, such as is very prominent in the *Cryptobranchidae*.

The legs are always well developed. The appressed toes may overlap along the sides, or be separated by as many as four costal folds. This varies individually, as well as with age and sex. Young have proportionately longer legs than adults as determined by this criterion. Among the adults the males have longer legs than the females.



Larval *Onychodactylus* have a fold of skin along the hind border of the limbs as do the *Cryptobranchidae*.

According to Noble (Bull. Amer. Mus. Nat. Hist., XLVI, 1, pp. 1-87, 1922) the *Cryptobranchidae* differ from other salamanders in having the pubotibialis muscle fused with the puboischiotibialis, and in having the iliotibialis not in contact with the ilioextensorius. My own dissections of *H. leechii* and of *O. japonicus* show agreement with the *Cryptobranchidae* in that they too have the pubotibialis fused with the puboischiotibialis, but in the other character they agree with the majority of salamanders and the two muscles in question are in contact nearly throughout their length. Dr. Noble holds that the *Cryptobranchidae* are primitive in having these muscles separated, but I think this view untenable, as they are in contact in *Hynobius* and in *Onychodactylus*, and I would suggest that their separation in *Cryptobranchidae* is a consequence of the dorso-ventral flattening which these animals have undergone, the flattening and widening of the thigh having drawn these muscles somewhat apart.

I find the following elements in the carpus of *H. leechii*: radiale, ulnare (to which is fused the intermedium), two centralia, four carpalia, and a bit of cartilage corresponding to the tubercle under the base of the first finger which according to Kehrler is a rudiment of the prepollex. In the tarsus I find tibiale, intermedium, fibulare, two centralia, six tarsalia and a bit of cartilage corresponding to the tubercle under the base of the first toe. These small bits of cartilage are distal to and in line with the radiale and first carpale and the tibiale and first tarsale respectively. All the other elements as well as the digits converge strongly towards the ulnar or the fibular. This state of affairs is quite in consonance with the findings of Wiedersheim, Kehrler, and Schmalhausen, in *H. keyserlingii* and in *Ranodon*. Their conclusions were that the original Tetrapod appendage was heptadactylous, and that these Asiatic salamanders had the most primitive carpus and tarsus found in living Tetrapods. The tubercles at the bases of the first digits are of almost universal occurrence in Hynobiids, and Kehrler's idea that they represent prepollex and prehallux is worthy of consideration.

The fifth toe is lacking in *Batrachuperus*, in *H. keyserlingii*, and in *H. cristatus*. It is nearly always absent in *H. kimurai*, and may occasionally be missing or rudimentary in other species of *Hynobius*.

*Batrachuperus* and *Pachypalaminus* have the under surfaces of the hands and feet and the tips of the digits covered with thickened, horny epidermis.

The larvae of both species of *Onychodactylus* possess claws, and these are present also in the breeding adults of the Japanese species.

The tail varies from short and thick, to very flat, and to long and slender. *H. kimurai* offers the extreme development of the first type; *Ranodon*, *Batrachuperus*, *Pachypalaminus*, *H. vandenburghi*, and *H. retardatus* are examples of the second; *Onychodactylus* has the third type of tail.

*H. leechii* and its allies with a moderately long tail, cylindrical at the base, and flattened towards the tip, perhaps represent the primitive tail form. The proportionate length of the tail increases with age.

The larvae of *Hynobius* and of *Batrachuperus* have a dorsal fin on the body. This is not present in larvae of *Onychodactylus*, the fin being restricted to the tail, and as this is the case in most mountain brook forms, it is probably confined to the tail in *Ranodon* also.

The gill filaments or fimbriae of *Hynobius* larvae arise from the ventral edges of long filament bearers or rami. These are very short in *Onychodactylus* larvae and absent in larvae of *Batrachuperus* so that the filaments seem to arise directly from the dorsal part of the septum.

*Onychodactylus* has no lungs. The other forms have the lungs well developed. However, the ypsiloid cartilage, so generally lacking or aborted in lungless salamanders is normally developed in *Onychodactylus*.

The tongue is sessile, but free at the lateral and posterior edges, save in *Batrachuperus*, where it is very small, apparently not free at the edges, and seems to be retractile into a sort of sheath. The hyobranchial skeleton of *Batrachuperus* does not differ from that of *Hynobius*.

Males of the family lack the papillae which line the cloaca in males of *Ambystomidae*, *Salamandridae*, *Plethodontidae*, *Proteidae*, and *Amphiumidae*, and which secrete the spermatophores by means of which internal fertilization is accomplished in these families. The spermatheca, found in females of the families just mentioned, is lacking in females of the *Hynobiidae*. In both male and female characters the *Cryptobranchidae* agree with the *Hynobiidae*. The fertilization of the former is well known to be external. The fertilization of the latter is known from two observations (Dybowski 1870, *H. keyserlingii*; Kunitomo 1910, *H. nebulosus*) both of which indicate external fertilization; and these, together with the anatomical evidence, may well mean that this method is in vogue throughout the family.

The vent of female *Hynobius* is a simple longitudinal slit; but males of this genus, probably at the breeding season, develop additional

slits and reduce the original one, so that the end result is a transverse slit. The process of change has not been observed, but as a completely graded series can be found to connect the most extreme types, it seems logical to suppose that there is an actual change in the shape of the vent in individuals. All young have the vent of the female type. The simplest type of male vent is a longitudinal slit with a small papilla at the anterior end. This papilla gives the vent a Y-shaped appearance, the two arms of the Y being very short; next in order of complexity is the above condition with the addition of two lateral slits, directed obliquely forward, nearly as long as the median slit, and meeting it or the arms of the Y near the point of forking. A third type lacks the median slit, but otherwise is like the form just described and is somewhat M-shaped, or X-shaped, the exact form depending on the length and obliquity of the two lateral slits, which may be almost parallel or may make an angle of almost 180 degrees. These various conditions are subject to many minor changes. They are not specific, as I have observed the same series of conditions in several different species of *Hynobius*.

In *Onychodactylus* two pairs of slits directed obliquely forward meet the longitudinal slit in both sexes.

In *Batrachuperus* there is an irregular star-shaped or cruciform arrangement of the slits.

Color pattern when present is in the form of a light dorsal band, but this is often visible only on the middorsal line of the tail. This light band is most prominent in *Onychodactylus* and in *H. keyserlingii*. In most of the species there is no definite color pattern, and the animals are marbled or spotted with dark and light in varying proportions.

The habits of *Batrachuperus* and of *Pachypalaminus* are unknown. Of *Onychodactylus* we know only that it breeds in the spring and that it frequents mountain brooks. *Ranodon* lives in mountain brooks, breeds in the spring, and lays eggs in spindle-shaped sacs attached to the under side of stones in streams. *Hynobius* lives on land, goes to ponds in the spring to breed, and lays eggs in spindle-shaped sacs attached to objects in the water. The eggs are pigmented, of small vitelline content, and the larvae emerge in a very immature condition. Save for the external fertilization, *Hynobius*, in its habitat reactions and breeding habits, resembles the common American *Ambystoma maculatum*.

Measurements are in millimeters. The head is taken from the tip of the snout to the gular fold; the body from thence to the posterior angle of the vent; and the tail from that point to the tip. When I have

a small series of a species I give measurements of all. In the case of very large series I give measurements of a selected group of specimens, including all the largest males and females, the smallest transformed young, and the largest and smallest larvae.

In the inclusion of references in the synonymy I have used my own judgment and left out nominal references which added nothing to the previous knowledge. I have included all unverified references on the chance that they may contain useful information which I have been unable to procure. Such are many of the Russian citations. The literature of this group is extraordinarily difficult, much of it being couched in Russian and in Japanese, contained in journals which are peculiarly hard to come by, and whose contents are not listed in the Zoological Record. As examples I mention the important papers of Nikolski (1918), Abé (1921), and Maki (1921), all three of which I saw for the first time when this paper was in galley proof. I therefore crave indulgence for unintentional omissions.

Another difficult matter has been the allocation of the proper names to some of the Japanese forms. The old terms *naevius* and *nebulosus* have been applied in their time to many species, and while the strict application of these two names is easy enough, it is by no means easy to tell what others than Schlegel meant by them. It is a pleasure to me to acknowledge my debt to the work of K. Tago. He, with his wide field experience, and large series of specimens, stated that he knew personally four *Hynobius* from Hondo. I, with a small series, came to the same conclusion, and have been able to identify them with Tago's four. His descriptions of the forms in nature are singularly charming and I have quoted largely from them.

In this paper I have included what I consider to be the essentials of a systematic treatise. These are: a consideration of the anatomy as used in classification; an account of the forms in the group and their distribution; an account of the relationships of these forms to one another and of their probable origin and dispersal; an account of their habits; references to the names by which they have been known and to the papers which contain information concerning them; references to the collections in which are deposited the specimens upon which the accounts are based. I have combined the introduction and the conclusions because the general student will read only this part and no useful purpose is served by sandwiching it around the systematic account of the animals.

This paper is based upon the examination of 1128 specimens of the family, representing 4 genera and 15 species. I have not been able to

examine specimens of *H. chinensis*, *H. turkestanicus*, *H. cristatus*, or of *Pachypalaminus boulengeri*. 1001 of these specimens are in the collection of the California Academy of Sciences and I am greatly indebted to the kindness of Dr. Van Denburgh for the opportunity of examining them, and for some notes which he sent me on the unique type of *Pachypalaminus*. I am also indebted to Dr. Leonhard Stejneger for permission to examine the *Hynobiidae* in the collection of the National Museum; to Dr. Thomas Barbour for the loan of material from the Museum of Comparative Zoology; to Dr. G. K. Noble for the loan of the American Museum specimens; to Dr. H. H. Wilder for the type of *H. kimurai*; to Mrs. Arthur Johnson for copies of the original descriptions of *H. cristatus* and *H. chinensis*; to Dr. H. M. Parshley for casting a critical eye over the whole; to Mr. Tadanori Ono for skilful rendition of Japanese into English; to Mr. Austin Clarke and Miss Alexandria Gerecht for similar help with the Russian; and to Mr. Shunichi Ono for several of the most important Japanese papers.

#### Family HYNOBIIDAE Cope.

1850. *Molgidae* Gray, Cat. Bat. Grad. Brit. Mus., p. 14.  
1858. *Ellipsoglossidae* Hallowell, Journ. Acad. Nat. Sci. Philadelphia, (2), 3, p. 339.  
1859. *Hynobiinae* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 125.  
1866. *Hynobiidae* Cope, Journ. Acad. Nat. Sci. Philadelphia, (2), 6, p. 107.

RANGE: From the Urals to Kamchatka, Sakhalin, and the Islands of Japan; Formosa; Sosova River, Verkoyansk, and Anadyr to Semi-ryechensk and Sze-chuan.

DIAGNOSIS: A family of salamanders which complete the transformation; haemal arch complete in tail vertebrae; ribs not forked proximally; prearticular bone present; first epibranchial and first ceratobranchial fused into a cartilaginous rod; second epibranchial present; nasals meeting in middorsal line; nasal spines of premaxillae very short; no fronto-squamosal arch; pterygoids present; prevomer long or short; no parasphenoid tooth patches; lungs present or absent; ypsiloid cartilage present; pubotibialis muscle fused with the puboischiotibialis; fertilization external; males without papillae in cloaca; females without spermatheca; no excessive dorso-ventral flattening; iliotibialis muscle in contact with ilioextensorius; vomerine teeth not anterior in position, not parallel to maxillary teeth; 5 genera, 21 species.

*Key to Genera of Larvae.*

Gill rami short or absent.

Horny claws, dorsal fin present only on tail.....*Onychodactylus*

Horny soles, dorsal fin present on body.....*Batrachuperus*

Gill rami long.

No claws or soles, dorsal fin present on body.....*Hynobius*

*Key to Genera of Adults.*

A. Vomerine teeth in more or less continuous angular series.

B. Lungs present; no claws or horny soles; vomerine teeth usually in V-shaped series; tail never long and cylindrical.....*Hynobius*

BB. Lungs present; horny soles on feet; vomerine teeth in V-shaped series; tail flat.....*Pachypalaminus*

BBB. Lungs absent; claws present in some specimens; vomerine teeth in nearly straight line across mouth; tail long and cylindrical.

*Onychodactylus*

AA. Vomerine teeth in two small widely separated series.

B. Toes 4; horny soles present; labial folds much developed.

*Batrachuperus*

BB. Toes 5; no horny soles; labial folds not developed.....*Ranodon*

Genus *HYNOBIUS* Tschudi.

1838. *Pseudosalamandra* Tschudi, Mem. Soc. Sci. Neuchâtel, pp. 56, 91 (type *Salamandra naevia* Schlegel).

1838. *Hynobius* Tschudi, Mem. Soc. Sci. Neuchâtel, pp. 60, 94 (type *Salamandra nebulosa* Schlegel).

1839. *Molge* Bonaparte, Icon. Fauna Ital., 2, fasc. 26 (type *Salamandra naevia* Schlegel), (not *Molge* Merrem 1820, Syst. Amph., p. 185).

1848. *Hydroscoptes* Gistel, Naturg. Thierr., p. XI (substitute for *Pseudosalamandra* Tschudi).

1854. *Ellipsoglossa* Duméril and Bibron, Erpet. Gén., 9, p. 97 (type *Salamandra naevia* Schlegel).

1870. *Salamandrella* Dybowski, Verh. Zool.-Bot. Ges. Wien, 20, p. 237 (type *Salamandrella keyserlingii* Dybowski).

1870. *Isodactylium* Strauch, Mem. Acad. Sci. St. Petersbourg, (7), 16, 4, p. 55 (type *Isodactylium schrenckii* Strauch.).

(*Hynobius* is used instead of *Pseudosalamandra* because Cope (1859), who first combined the two, selected *Hynobius*).

RANGE: From the Urals to Kamchatka, Sakhalin, and Islands of Japan; Formosa; from the River Sosova, Verkoyansk, and Anadyr, to Turkestan and Hupeh.

DIAGNOSIS: *Hynobiidae* with no foot modifications; lungs present; premaxillary fontanelle absent or very minute; gills of larvae with long filament bearers; vomerine teeth usually in V-shaped series; tail variable, never long and cylindrical; 16 species.

*Key to Adults of Hynobius.*

- A. Mainland forms. Vomerine series medium.
  - B. No light dorsal band, toes 5.
    - C. Very small scattered dark dots on light ground, 14 costal grooves, Turkestan.....*turkestanicus*
    - CC. Crowded spots or mottling, Eastern Asia.
      - D. Costal grooves 13, Korea.....*leechii*
      - DD. Costal grooves 11, Hupeh, China.....*chinensis*
    - BB. A light dorsal band, toes 4, costal grooves 13-15, Siberia...*keyserlingii*
  - AA. Island forms.
    - B. Inner branch of vomerine series equals or exceeds in length the distance between outer edge of naris and opposite naris; tail very short and thick; *naevius* group.
      - C. Toes 5.
        - D. Light markings both above and below, Kiusiu.....*stejnegeri*
        - DD. Light markings on sides and on belly, Hondo.....*naevius*
      - CC. Toes 4, light markings above and on sides, Hondo.....*kimurai*
    - BB. Inner branch of vomerine series equals or exceeds in length the distance between outer edge of naris and opposite naris; tail tapering, Formosa.  
*sonani*
    - BBB. Inner branch of vomerine series does not equal distance between outer edge of naris and opposite naris, but equals or exceeds in length the distance between outer edge of naris and peak of opposite vomerine series; tail more or less flat; *nebulosus* group.
      - C. Sides of tail black.
        - D. Tail very flat, males not black, Hondo.....*vandenburghi*
        - DD. Tail not flat, males black, Tsu-shima South.....*tsuensis*
      - CC. Sides of tail not black.
        - D. Middorsal line of tail usually yellow, spots on body black.
          - E. Tail flatter, spotting coarser, ground color lighter, Kiusiu.  
*nebulosus*
          - EE. Tail less flat, spotting finer, ground color darker, Iki-shima.  
*ikishimae*
        - DD. Middorsal line of tail not yellow; very fine stippling of dark brown on light brown ground color; Tsu-shima North.....*tagoi*
    - BBBB. Length of inner branch of vomerine teeth does not equal distance between outer edge of naris and peak of opposite series; *peropus* group and *cristatus*. (*H. leechii* bridges gap between the *peropus* and *nebulosus* groups.)



- C. Pale, with darker marbling; 11-13 costal grooves; vomerine series medium to short; toes usually 5; tail keeled above; Hondo. .*peropus*  
 CC. Pale, with a dark lateral band; 11-12 costal grooves; vomerine series very short; toes 5; tail very flat; Yezo. ....*retardatus*  
 CCC. Black; 14 costal grooves; vomerine series medium; toes 4; tail flat; Sakhalin. ....*cristatus*

#### HYNOBIUS LEECHII Boulenger.

1887. *Hynobius leechii* Boulenger, Ann. Mag. Nat. Hist. (5), 19, p. 67; Stejneger, 1907, U. S. Nat. Mus. Bull., 58, p. 29, pl. 4, f. 8; Abé, 1921, Tokyo Zool. Mag. 34, p. 330.

TYPE: In British Museum, collected by Mr. J. H. Leech.

TYPE LOCALITY: Gensan (Wonsan), Korea.

RANGE: Korea.

DIAGNOSIS: Vomerine series short to medium; tail somewhat flattened; usually 13 costal grooves; toes 5; sides of tail not black; middorsal line of tail not yellow; grayish brown with black mottling.

DESCRIPTION: Cal. Acad. Sci. No. 31856, adult male, Fusan, Korea, collected May 8, 1911, by Victor Kuhne; 14 costal grooves, one costal fold between appressed toes; head width  $5\frac{2}{3}$  in length from snout to vent; head length  $3\frac{1}{2}$  in length of body; head oval as seen from above; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; a tubercle under base of first finger and first toe; tail shorter than body, cylindrical at base, trigonal in middle, flattened at tip, ending in an obtuse point; vent a slit forking forward, a small tubercle in fork; vomerine teeth beginning behind inner border of nares, a short forward and incurving branch, and a long straight branch extending back and a little in; series separated from its fellow by length of outer branch, length of inner branch not quite equal to the distance between outer border of naris and peak of opposite series; head black above; light gray below a line joining insertions of legs; total length 105 mm., head 14, body 49, tail 42.

Variation: A female, Cal. Acad. Sci. No. 35958, same data, has 13 costal grooves, 3 costal folds between the appressed toes; head width  $5\frac{1}{3}$  in length from snout to vent; head length  $3\frac{2}{7}$  in length of body; tail somewhat thicker; vent a slit; inner branch of vomerine



series equal in length to distance between outer border of naris and peak of opposite series; yellowish brown above, light gray below, heavy mottling of irregular black spots above; total length 101 mm., head 14, body 46, tail 41.

A young specimen, Cal. Acad. Sci. No. 32126, same data, has 12 costal grooves; appressed toes meeting; head width  $4\frac{1}{2}$  in length from snout to vent; light grayish brown above, with mottling of dark brown; scattered white flecks; cream color below with gray mottling; tail much flattened, finned above; traces of recently resorbed gills at sides of neck; total length 47 mm., head 8, body 21, tail 18.

A larva, Cal. Acad. Sci. No. 32154, Chiksan, Korea, shows a light grayish brown dorsal surface, the sides and belly being white. Back and sides are marked with small irregular black spots. The dorsal fin reaches forward past the middle of the back. Total length 53 mm., head 8, body 23, tail 22.

A female from Wonsan, Korea, Cal. Acad. Sci. No. 32168, has the inner branch of the vomerine series equal in length to the distance between the outer edge of the naris and the median line; this is the case in three males from Chiksan (Cal. Acad. Sci. 32158-32160), and in seven specimens from Kong-ju (Cal. Acad. Sci. 32161-32167). It is closely approached by some of the Fusan specimens.

Among 317 adults of this species, two (32048, 31934) have no fifth toe; eight (31854, 31860, 31972, 32076, 32096, 35964, 35970, 31949) lack this toe on one foot; 3200 has both fifth toes rudimentary; 31964 has the fifth toe of the left foot rudimentary.

The costal grooves of 17 males are: 13 in 13 specimens, 13-14 in one, and 14 in three.

The count for 13 females is: 13 in twelve specimens, and 14 in one. Of 11 young one has 12 costal grooves, the rest have 13. Thus some 85% have 13 costal grooves.

In the young the legs are proportionately longer. Thus of 11 specimens the appressed toes meet in five, and are separated by one costal fold in six. This proportionate leg length is somewhat less in adult males, for five out of seventeen have the appressed toes meeting, in ten animals they are separated by one costal fold, and in two individuals by two. Females have still shorter legs, as out of fourteen adults seven have the appressed toes separated by three costal folds, three by two costal folds, and four from Kong-ju have only one costal fold between the appressed toes.

REMARKS: I have used this species for most of the anatomical work I have done on *Hynobius*.

This animal is about intermediate between the forms of the *nebulosus* group (which inhabit Hondo, Kiusiu, Shikoku, and the islands in the Korean straits), and *peropus* of the high interior of Hondo. It may therefore be taken to represent the mainland stock from which both these island groups have arisen. Its intermediate nature is seen in its dentition, its coloration, and its proportions. It could be confused more readily with *tagoi*, *ikishimae*, and *peropus*, than with *tsuensis*, *nebulosus* and *vandenburghi*.

All the *nebulosus* group have vomerine series as long as or longer than the maximum length found in *leechii*. *Tagoi* has a rather individual coloration which should distinguish it easily. *Ikishimae* has a longer vomerine series and nearly always has a yellow stripe on the middorsal line of the tail which *leechii* never has. *Peropus* has a vomerine series as short as the shortest in *leechii*, fewer costal grooves, longer legs, and a different coloration.

Besides the following localities Abé (1921) has recorded it from Hokkansen and Heijo.

Specimens seen: 347, as follows;

Korea: Kang-wom-do Province: Wonsan (= Gensan), 1 (Cal. Acad. Sci. 32168)

Tschhung-Tschhong-Do Province: Kong-ju 7 (Cal. Acad. Sci. 32161-32167).

Kwi-Do Province: Chiksan 34 (Cal. Acad. Sci. 32158-32160, 32138, 32127-32137 larvae, 32139-32157 larvae).

Kjong-Sang-Do Province: Fusan 305 (Cal. Acad. Sci. 31841-32126, 32374, 35958-35975).

#### MEASUREMENTS OF *Hynobius leechii*.

\* = costal grooves.

/ = costal folds between appressed toes.

Specimen	Locality	Sex	Total Length	Head	Body	Tail	*
Cal. Acad. Sci. 35969	Fusan	male	109	14	47	48	13/2
"	32070	"	108	14	54	40	13/0
"	31856	"	105	14	49	42	14/1
"	31923	"	102	13	48	41	13/1
"	32018	"	100	14.5	46.5	40	13/0
"	32067	"	101	13.5	49.5	39	13/1
"	31874	"	95	14.5	43.5	37	13/0
"	31975	"	94	13.5	46.5	34	13/2
"	32036	"	93	13	42	38	13/1
"	32037	"	93	13	41	39	13/0

Specimen	Locality	Sex	Total Length	Head	Body	Tail	*
Cal. Acad. Sci. 32095	Fusan	female	108	14	54	40	13/3
" 31942	"	"	106	14	49	43	13/3
" 32110	"	"	101	14	47	40	13/2
" 35958	"	"	101	14	46	41	13/3
" 31905	"	"	101	13.5	43.5	44	13/3
" 32008	"	"	100	14	47	39	13/2
" 32053	"	"	100	13	48	39	13/3
" 31903	"	"	100	14	46	40	13/2
" 32055	"	"	100	13	47	40	13/3
" 32069	"	"	98	15	49	34	13/3
" 32161	Kong-ju	male	95	13	52	30	14/1
" 32162	"	female	108	15	51	42	/1
" 32163	"	"	107	14	51	42	13/1
" 32164	"	male	89	12	43	34	14/1
" 32165	"	"	90	13	42	35	13/0
" 32166	"	female	73	11	33	29	13/1
" 32167	"	male	83	11.5	38	33.5	13/1
" 32168	Wonsan	female	90	12	43	35	14/1
" 32158	Chiksan	male	90	12.5	42.5	34	13-14/1
" 32159	"	"	79	11	39	29	13/1
" 32160	"	"	79	11	38	30	13/1
" 32138	"	young	53	8	25	20	13/0
" 31917	Fusan	"	60	10.	28	22	13/1
" 32024	"	"	60	9	26	25	13/1
" 32119	"	"	59	9	26	24	13/1
" 32686	"	"	58	8.5	27	22.5	13/1
" 32083	"	"	57	8.5	26.5	22	13/1
" 31979	"	"	55	9	25	21	13/1
" 31901	"	"	53	9	25	19	13/0
" 31873	"	"	48	8.5	23.5	16	13/0
" 32126	"	"	47	8	21	18	12/0
" 31937	"	"	40	8	23	9	13/0
" 32156	Chiksan	larva	61	9	26	26	
" 32137	"	"	56	9	22	25	
" 32146	"	"	43	7	17	19	
" 32154	"	"	53	8	23	22	
" 32144	"	"	57	9	22	26	

## HYNOBIUS CHINENSIS Günther.

1889. *Hynobius chinensis* Günther, Ann. Mag. Nat. Hist., (6), 4, p. 222.

TYPE: In British Museum, collected by Mr. Pratt.

TYPE LOCALITY: Ichang, Province Hupeh, China.

RANGE: Known only from type locality.

DIAGNOSIS: A *Hynobius* with short vomerine series; compressed tail; 11 costal grooves; 5 toes; no dorsal light stripe on body or tail.

DESCRIPTION: Having seen no specimens of this form I quote the original description. "Allied to the Japanese *Hynobius nebulosus*, but with the series of vomerine teeth much shorter, extending backwards only to the middle of the eyeball. General habit short and stout; head large, nearly as broad as long, its length being rather more than one fourth the length of the trunk. Tail compressed in its whole length, but without crest; body with eleven lateral folds. The limbs meet when appressed; fifth toe well developed; no carpal or tarsal tubercles. Skin smooth; gular fold indistinct. Nearly uniform horny black, the lower parts brownish, finely marbled with darker."

	( <i>H. leechii</i> , Cal. Acad. Sci. 32113, Fusan, Korea.)	
	( <i>H. chinensis</i> )	
Total length	85 mm.	81 mm.
From snout to cloaca	46 "	46 "
Length of head	11 "	11 "
Width of head	10 "	9 "
Fore limb	15 "	13 "
Hind limb	16 "	15 "
Tail	39 "	35 "

REMARKS: "Two specimens were collected by Mr. Pratt at Ichang."

This animal seems rather allied to *H. leechii* of Korea than to *H. nebulosus*. The slight proportional differences, a less number of costal grooves in the Chinese species, and a broader head than *H. leechii* are about all that distinguish it. *H. leechii* has 13-14 costal grooves.

#### HYNوبيUS TURKESTANICUS Nikolski.

1909. *Hynوبيus turkestanicus* Nikolski, Charikov Trav. Soc. Nat., 43, p. 73; 1918, Faune de la Russe, p. 245, f. 47, pl. 4, f. 4.

TYPE: Zool. Mus. Petrograd No. 2404, collected by V. Nikolski.

TYPE LOCALITY: Russian Turkestan ("Pamirs of Samarkand," Nikolski 1918).

RANGE: Known only from type locality.

DIAGNOSIS: A *Hynوبيus* with medium vomerine series; tail keeled

above and below; 14 costal grooves; 5 toes; no dorsal light stripe on body or tail; light with darker dots.

DESCRIPTION: "A *Hynobius* with head depressed, longer than broad; snout rounded, the length equalling interorbital width; palatine series as long as  $\frac{3}{4}$  width of tongue, not broader than long; length of eye  $1\frac{1}{2}$  times in interorbital width; eye prominent; no labial lobes; body cylindric, scarcely depressed; head length  $4\frac{1}{2}$  in length of body and head (tail omitted); snout to gular fold  $3\frac{1}{4}$  in distance from gular fold to anus; hind feet laid forward not reaching front feet laid back by more than length of head; fingers and toes well developed; fifth toe  $1\frac{1}{2}$  in length of fourth; carpal and tarsal tubercles indistinct; tail as long as gular fold to anus; tail keeled above and below, tip acuminate; anus a longitudinal slit, no transverse groove, no raised edges; body smooth, a deep middorsal groove forking on occiput, a longitudinal groove crossing parietal region of head; 14 transverse grooves on the sides reaching belly; paratoids on sides of head; a second gular fold between angles of jaws; a deep horizontal groove in side of head beginning at gular fold; body reddish brown above with small brown spots; below immaculate yellowish brown; total length 90 mm., head 10, body 40, tail 40."

Nikolski (1918, f. 47) shows the inner row of vomerine teeth equaling the distance from outer edge of naris to median line plus width of naris, and thus like those of *H. leechii*. Pl. IV, f. 4, a photograph of the type, shows it to be not fully transformed, and closely resembling *Ranodon sibiricus* in habit and markings.

REMARKS: This animal is not very different from *H. leechii* save in color. In this character it approaches *Ranodon sibiricus* rather closely.

It is particularly unfortunate that no specimens of this species are available because its relations with *Ranodon sibiricus* are of the greatest interest. The legs are shorter and there are more costal grooves, so that it is not particularly close anatomically, but geographically it is the only *Hynobius* at present available out of which *Ranodon* could have been evolved, so that the animal should be examined very carefully for any similarity.

#### HYNOBIUS KEYSERLINGII (Dybowski).

1853. *Salamandra terrestris* (?) Zerrenner, Erdkunde Gouv. Perm., p. 321.

1859. *Triton* nov. sp., Maack, Putesh. Amur, p. 154.

1870. *Salamandrella Keyserlingii* Dybowski, Verh. Ges. Wien, 20, p. 237, pl. 7; Strauch, 1870, Mem. Acad. Sci. St. Pétersbourg, (7), 16, 4, p. 110; Wiedersheim, 1876, Morph. Jahrb., 2, p. 426, pl. 29, f. 4-5, (extremities); 1877, Morph. Jahrb., 3, pl. 21, ff. 39, 51, pl. 24, ff. 85-6, pl. 25, f. 98 (skull); Boulenger, 1882, Cat. Bat. Grad. Brit. Mus., p. 34; Mueller, 1887, Verh. Ges. Nat. Basel, 8, (2), p. 249; Kulagin, 1888, Izv. Mosc. Obsch. Lyub. Est., 56, (2), p. 34; Slovtzov, 1892, Pozv. Tyumensk okr., p. 75; Kastschenko, 1896, Izv. Tomsk Univ., 10, p. 1 (habits); Bedriaga, 1898, Wiss. Res. Przezwalski Zentralasiat. Reise, Zool., 3, (1), Amph., p. 3; Wolterstorff, 1898, Blatt. Aqua. Terr., 9, p. 91; Anikin, 1902, Otc. O. Komand. Narymsk. Kr., p. 104; Kastschenko, 1902, Izv. Tomsk Univ., p. 20; Nikolski, 1905, Zap. Imp. Akad. Nauk. S. Peterburg (8), 17, p. 436; Elpateevski, 1905, Trud. Troitzko-Savsk. Otd. Geog. Obstch. 9, p. 43; 1907, Op. Pres. Zemn. Ross. Imp., p. 180; Stejneger, 1907, Bull. U. S. Nat. Mus., 58, p. 37, pl. 5, ff. 7-8, ff. 33-38; Schmalhausen, 1910, Mosk. Dnevn., 12, p. 289 (extremities); 1910, Anat. Anz., 37, p. 431 (extremities); Cugunov, 1911, Ann. Mus. Zool. St. Pétersbourg, 16, p. 220; 1913, Ann. Mus. Zool. St. Pétersbourg, 18, p. 250; 1914, Ann. Mus. Zool. St. Pétersbourg, 19, p. 532; Nikolski, 1915, Trud. Troitsko-Savsk. Otd. Geog. Obstch. 15, p. 37; 1918, Faune de la Russe, p. 236, f. 44.
1910. *Hynobius Keyserlingii* Boulenger, Les Batraciens, pp. 49, 96.
1870. *Isodactylum Schrenkii* Strauch, Mem. Acad. Sci. St. Pétersbourg, (7), 16, p. 56, pl. 2, f. 1, (Ussuri R., Shilka R., Lake Baikal); Sabaneef, 1872, Bull. Soc. Nat. Moscou, 44, p. 275; 1874, Pozv. Sred. Urala, p. 190; Kehrre 1886, Ber. Nat. Ges. Freiburg, I, p. 5, pl. 4, f. 5-6 (extremities); Shitkov, 1895, Zool. Anz., 18, p. 165 (development); 1899, Zool. Anz., 22 (extremities); 1900, Dnev. Otd. Ichtiol. Akklim. Zhiv., 2, p. 41 (habits); 1902, Izv. M. Obstch. Lyub. Est. Antr. i T. D., 98, Tr. Zool. Otd., 13, Dnev. Zool. Otd., 3, (4), p. 5 (extremities).
1870. *Isodactylum wosnessenskyi* Strauch, l. c., p. 58, pl. 2, f. 2a-d, (Javina, Kamchatka); Wiedersheim, 1876, Morph. Jahrb., 2, p. 426, pl. 29, f. 6 (extremities).
1882. *Salamandrella wosnessenskyi* Boulenger, Cat. Bat. Grad. Brit. Mus., p. 34; Kulagin, 1888, Izv. M. Obstch. Lyub. Est., 56, (2), p. 74.
1896. *Salamandrella uralensis* Nikolski, Ann. Mus. Zool. St. Pétersbourg, 1, p. 13, (nomen nudum).
1905. *Salamandrella Keyserlingii tridactyla* Nikolski, Zap. Imp. Akad. Nauk. S. Peterburg, (8), 17, p. 491 (Vladivostok).
1921. *?Hynobius doii* Abé, Tokyo Zool. Mag., 34, p. 330 (Manchuria).

TYPE: None mentioned.

TYPE LOCALITY: Southwest corner of Lake Baikal.

RANGE: From the River Sosova, the Ural Mts., and the Kirgis Steppe, to Verkoyansk, Anadyr, Kamchatka, and south into Manchuria, and Mongolia.

DIAGNOSIS: A *Hynobius* with moderately long, flattened tail; moderate vomerine series; 13-15 costal grooves; 4 toes; a light dorsal band and darker sides.

DESCRIPTION: U. S. Nat. Mus. No. 36414, adult male, Paratunka, Kamchatka; 14 costal grooves; 1 costal fold between appressed toes; head width 5 in length from snout to vent; head length  $3\frac{1}{2}$  in length of body; head oval; eye shorter than its distance from tip of snout; outline of upper jaw convex as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from hind angle of eye not quite reaching gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 1, 4 in order of length; toes 3, 2, 4, 1 in order of length; tail longer than body, much flattened, a dorsal keel throughout, a ventral keel in distal two-thirds; vent formed by three slits converging with apex forwards, median longest; vomerine series beginning behind inner edge of nares; a branch of 5 teeth running in and forward to level of anterior edge of nares; a branch of 8 teeth running in and back, making an acute angle with the outer branch, and extending farther back than it; series separated from its fellow posteriorly by width of nares; length of inner branch equals distance between outer edge of naris and median line; dull grayish brown, lighter below; an irregular black line from behind eye along sides of back to base of tail where it broadens into irregular marbling on sides of tail; a middorsal black line; dorsal area of a richer brown than sides; total length 132 mm., head 15, body 52, tail 65.

Variation: A female, U. S. Nat. Mus. No. 22594, from Rakovaya Bukhta, Avatcha Bay, Kamchatka, has 4 costal folds between the appressed toes; head width 7 in length from snout to vent; head length 4 in length of body; tail shorter than body, no keels; vent a simple slit; 13 teeth in the inner branch of the vomerine series, whose length is a little more than equal to the distance between the outer border of the nares and the median line; darker, with irregular black marbling on sides of body as well as on sides of tail; total length 124 mm., head 15, body 60, tail 49.

Variations in proportions may be noted in the table of measurements. Males are longer legged than females.

HABITS: I quote first from Dybowski (1870) who says, in his original description; "I have found this species at the southwest



corner of Baikal, especially in the marshy coastal meadows of the Kultusnaya and Pachabicha valleys, where it is very abundant. On the tenth of May 1869 I found grown animals, about 130 mm. long, laying eggs in pools and ponds. The females lay their eggs in string-like bunches and glue them to stalks of plants or other objects in the water near the surface; the males emit their sperm over the eggs while moving hither and thither very actively. The animals are very shy and at the slightest disturbance they dive under and either creep into the mud or cling motionless flat on the bottom. In either case they can easily be caught with nets. After the egg-laying, about the first half of June the adults leave the water and live in low, swampy meadows; either in moss or under pieces of wood or else in rotten logs. The immature animals stay in such places throughout the summer.

"Reckoning by the sizes of the hundreds of specimens we caught, *Salamandrella Keyserlingii* reaches its full development and puberty in the third year. The food of this animal consists of earthworms and of insects. Pregnant females kept in the aquarium will not lay eggs; and young experimentally kept in water soon perish; but I have kept both young and adults alive for months in damp moss, and fed with earthworms."

Shitkov (1895), speaks of the habits near Ekaterinburg in the following terms: "The eggs are laid by the females in especial gelatinous sacks, which are fastened by one end to a plant or other object in the pond, and not far (2-3 cm.) from the surface; the other end of the sack hangs freely in the water, so that it will be rocked up and down by the slightest movement of the water. The sack is generally 15 cm. long, much longer than the breadth, (the breadth of the empty, collapsed sack is 2 cm.), bowed, and thickly wrinkled on the inner side. The wall of the sack is of the same origin as the albuminous coating of the egg. It is certain, however, that each egg has its own shell, which I, (although I myself owing to my late arrival in Ekaterinburg have seen no new-laid eggs), conclude from the fact that the larvae just after their emergence are still surrounded by a transparent gelatinous covering, from which they free themselves immediately after their emergence. Each sack contains 50-60 eggs."

"According to Mr. A. Hackel the adults enter the water on the twenty-first of April, and lay their eggs on the same night."

"The larvae which were in a sunny aquarium emerged after 14 days; those in an aquarium which faced the North in 23 days. At the time of my arrival in Ekaterinburg (the last of May) the larvae in the aquarium of Mr. Hackel were already 3 cm. long and had both



pairs of limbs. At the same time I found sacks in the open, in ponds near Lake Schartasch about six versts from Ekaterinburg, which still contained larvae. These were ripe for emergence. They were distinctly backward in their development compared with those shown me, which is probably to be explained by the cold weather of last May in East Russia."

"All the larvae whose emergence I had the opportunity to observe, agreed in breaking out of the lower part of the sack. Larvae from the same sack, were often not equally developed, as appeared best in the gills. This unequal development seems to me accounted for by the position of the sack, one end of which is placed in the influence of the warmer weather, while the other is much deeper in the water.

"The newly emerged larva is about 10 mm. long and is marked by the length (1 mm.) of the balancer. The gills of the more advanced ones bear two or three filaments apiece; the gills of the less advanced only two on the second gill. The fore-limbs are visible as little knobs."

The egg sack, as figured by Shitkov, bears a striking resemblance to that of *H. naevius*, as figured by Tago (1907).

Kastschenko (1896), "found the animals in May near Tomsk on the ground near a pond under the dead leaves of the last fall.

"They do not enter the water save for breeding.

"The eggs are laid near Tomsk in the middle of May. They are always in a transparent sausage-shaped bag, which is fastened to plants under water, near the surface, usually 1-2 vershok (2-4 inches) from it, and not deeper than  $\frac{1}{4}$  the depth of the water. Two bags are together, probably laid by one female. The gelatinous walls of the bag can support all the movements of the water, but when taken out they separate on account of their own weight. The bag is somewhat spiral, so that there are narrow and wide places.

"They are fastened to any under water plant or dead branch fallen from the surrounding trees.

"The end of larval life and the time of leaving the water is at Tomsk during the first days of August."

REMARKS: I am unable to distinguish between the Kamchatkan specimens and those from southeastern Siberia. There seems to be no break in the distribution, and I have seen no evidence of local differences.

This animal is quite distinct and there is no danger of confusion with *H. leechii* of Korea. It is the only member of the genus with a light dorsal band. Its relations seem remotely with *leechii* of Korea

and less remotely with *cristatus* of Sakhalin. It has almost certainly given rise to the latter.

The animal has been recorded from Sze-chuan by Bedriaga (1898), but this record refers in reality to *Batrachuperus sinensis*; and Nikolski's (1905) record for Sakhalin probably refers to *H. cristatus*.

Abé (1921) mentions a *Hynobius doi* from Manchuria. This name is based on two larvae and probably refers to *keyserlingii*.

Besides the localities from which I have seen specimens, it has been recorded from the following:

Russia proper: Nishne-Tagilsk (Nikolski 1905); Middle region of Urals from Orenburg district to Bogoslovsk, especially Ekaterinburg and Chasninsk (Sabaneef 1871); Baschkiri Urals (Zarudny 1895).

Tobolsk Gov.: Tyumen, Tobolsk (Slovtzov 1892); Sosova River (Gondatti 1888); Surgut (Cugunov 1914); River Pyderata (Nikolski 1918).

Tomsk Gov.: Narimsk (Anikin 1902); Tomsk (Kastschenko 1896); Ischmorsk, Krasnaya (Kastschenko 1902).

Yenisseisk Gov.: Minussinsk (Martianov 1881); Ilanskaya (Cugunov 1911).

Yakutsk Gov.: Verkoyansk (Wolterstorff 1898); Aldan River, Yakutsk, Lena River above Schigansk (Nikolski 1905).

Irkutsk Gov.: Irkutsk, Zima (Cugunov 1913); Kultuk (Maack 1859); Irkut River, Lower Tunguska River (Nikolski 1905); Southwest corner of Lake Baikal (Dybowsky 1870).

Transbaikalia Gov.: Dauri, Ust-Strielka (Maack 1859); Schilka R., (Strauch 1870); Ingoda R. (Dybowsky 1870); Tschita (Nikolski 1915).

Maritime Gov.: Khabarovka (Mueller 1887); Amur R. (Kulagin 1888); Agdeki, Kazlovkaia, Vladivostok (Nikolski 1905); Imansk, Schmakovkaia (Nikolski 1918).

Kamchatka Gov.: Tolbatcha, Uson Volcano, (von Ditmar 1890); Anadyr, (Nikolski 1905); Konina (Kulagin 1888); Javina (Strauch 1870).

Mongolia: Northern Mongolia (Bedriaga 1898).

It has also been recorded from the following, which I am unable to place under special provinces: Kirgis Steppe, Dolguloch (Nikolski 1905); Raktiya R., in western Siberia (Kulagin 1888); Zej River (Dolbuka) (Nikolski 1918); Njado-dla-pa-mal (Nikolski 1918).

Specimens seen: 19, as follows;

Lake Baikal 2 (Mus. Comp. Zool. 1288); I-mien-po, Manchuria 1 (U. S. Nat. Mus. 53366); Lake Xanka 1 (Cal. Acad. Sci. 14578);

Gichiga 2 (Amer. Mus. 1452-3); Kamchatka 5 (U. S. Nat. Mus. 31712-6); Avatcha Bay, Kamchatka 1 (U. S. Nat. Mus. 22594); Paratunka, Kamchatka 7 (U. S. Nat. Mus. 23521, 36414-9).

MEASUREMENTS OF *Hynobius keyserlingii*

\* = costal grooves.

/ = costal folds between appressed toes.

Specimen	Locality	Sex	Total length	Head	Body	Tail	*
M. C. Z. 1288	Lake Baikal	♂	115	13	48	54	14/2
"	"	♂	68	9	34	25	14/4
Cal. Acad. Sci. 14578	Lake Xanka	♂	75	9	34	32	14/2
U. S. N. M. 53366	I-mien-po	♀	95	12	35	38	
Am. M. N. H. 1452	Gichiga	♀	75.5	10.5	35	30	14/
" 1453	"	♀	93	11.5	44.5	37	14/4
U. S. N. M. 22594	Avatcha Bay	♀	124	15	60	49	14/4
" 23521	Paratunka	♀	111	14	52	45	14/3
" 36414	"	♂	132	15	52	65	14/1
" 36415	"	♂	116	14	51	51	14/3
" 36416	"	♂	130	16	53	61	13/2
" 36417	"	♂	128	15	58	55	14/1
" 36418	"	♂	111	14	56	51	14/1
" 36419	"	♀	114	13	59	42	15/4
" 31712	Kamchatka	♀	112	14	55	43	15/3
" 31713	"	♀	117	14.5	52.5	48	14/4
" 31714	"	♀	120	15	59	46	14/3
" 31715	"	♂	110	15	49	46	14/2
" 31716	"		99	13			
Types of <i>I.</i>	Javina		121	14	48	59	14-15/
<i>wosnessenskyi</i>			108	13	41	54	14-15/
(Strauch 1870)			98	12	43	43	14-15/
in Petrograd			92	12	42	38	14-15/
Museum			85	11	38	36	14-15/
<i>I. schrenkii</i> Type	Siberia		107	14	44	49	14/
(Strauch 1870) in							
Petrograd Museum							

## HYNOBIUS CRISTATUS (Andersson).

1905. *Salamandrella keyserlingii* Nikolski (part), Zap. Imp. Akad. Nauk, S. Peterburg, (8), 17, 1, p. 436.
1917. *Salamandrella cristata* Andersson, Medd. Göteborg Mus. Zool. Afdel. 10.

TYPE: Göteborg Museum No. 302, collected by Mr. L. Munsterhjelm.

TYPE LOCALITY: Sakaehama, east coast of Sakhalin.

RANGE: Sakhalin.

DIAGNOSIS: A *Hynobius* with long, flat tail; moderate vomerine series; 13 costal grooves; 4 toes; black.

DESCRIPTION: Quoted from Andersson (1917). "Vomero-palatine teeth in an angular series; the median arms which converge behind form an acute angle, and equal one-half the width of the tongue; the lateral branches, of about half the length of the inner ones, form right angles with the latter. Head flat and broad; nostrils about halfway between eye and tip of snout, their distance from each other more than the interorbital width. Eye rather large, the upper eyelid considerably longer than the interorbital space. Body moderately elongate; distance from tip of snout to gular fold contained three times in distance from gular fold to anterior border of vent. Adpressed limbs just meeting; fingers and toes four on each foot, short, broad, and depressed; toes with a rudiment of web at the base; outer finger very small, second and fourth of about similar size, third much the longest and broadest; of toes, the outer (fourth) as long as but somewhat narrower than the innermost (first), both much smaller than second and third, of which the latter is somewhat longer and narrower than the former. No trace of a fifth toe. Tail long, as long as head and body, very compressed in its whole length, tapering, obtusely pointed at the end, crested by a high dorsal and a lower ventral fin, both bordering the whole tail. Thirteen distinct costal grooves, twelve abdominal ones, the inguinal not continuing across the belly; median dorsal groove not distinct. A large, very distinct parotoid gland; a distinct postocular groove continues along the upper and posterior margin of the gland to the gular fold, which is very distinct. Vent a longitudinal slit with a broad triangular flap, directed forwards, protruding between the anterior parts of the very swollen lips, and forming a kind of roof over the external opening. Colour black, except on the chin and throat to the gular fold, which parts are brownish white, and on the breast and under parts of limbs, which are brown.

Dimensions of the single specimen, which is a female. (Ba. ex. 302). Total length 110 mm., head 14, gular fold to anterior angle of vent 41, anterior angle of vent to tip of tail 55."

REMARKS: I am inclined to believe that the sex is wrongly determined. The modification of the vent described above is a male character.

This animal occupies territory between the ranges of *H. keyserlingii*

and *H. retardatus*. I have seen no specimen of *cristatus* but it seems to be more allied to *keyserlingii*, on account of the dentition, the costal groove count, and the feet, which are the same as those of the Siberian form and very different from those of the Yezo animal. On the other hand the tail is quite like that of *retardatus*. But the Yezo species seems to me to be an end form, very specialized, derived from *peropus* of Hondo, and while the matter cannot be regarded as settled, it is far more probable, both anatomically and geographically to regard *cristatus* as derived from *keyserlingii*, from which it differs, as Andersson says "very clearly in the structure of the tail, which is higher, longer, more compressed, and crested; also the colour is quite dissimilar. In addition to this the vent has a triangular flap, the limbs are longer, and the body shorter in proportion to the head."

Nikolski's reference (1905) to a specimen of *keyserlingii* in the Petrograd museum from Sakhalin (No. 1941, collected by Dr. Saprunenko in 1890), probably refers in reality to *cristatus*.

#### HYNOBIUS PEROPUS Boulenger.

1882. *Hynobius nebulosus* Boulenger (part ?), Cat. Batr. Grad. Brit. Mus. (2), p. 32; Okada 1891, Cat. Vert. Japan, p. 65; Stejneger 1907, Bull. U. S. Nat. Mus. 58, p. 30, ff. 23-26; Sternfeld, 1916, S. B. Ges. Nat. Fr. Berlin, p. 172; Abé 1921, Tokyo Zool. Mag., p. 330.
1882. *Hynobius peropus* Boulenger, loc. cit., p. 33, pl. 2, f. 1; Stejneger, loc. cit., p. 32, pl. 4, ff. 4-7; Tago, 1907, Tokyo Zool. Mag. 19, p. 202; Hashimoto, 1910, Tokyo Zool. Mag., 22, p. 497.
1883. *Hynobius lichenatus* Boulenger, Ann. Mag. Nat. Hist., (5), 12, p. 165, pl. 5, f. 1, (Aomori, Mottsu Prov.); Stejneger loc. cit., p. 36, pl. 4, ff. 1-3; Tago, loc. cit., p. 203; Hashimoto, loc. cit., p. 497.
1907. (July 22) *Hynobius nigrescens* Stejneger, loc. cit., p. 34, ff. 27-32 (Sendai, Rikuzen Prov.); Tago, loc. cit., p. 204; Hashimoto, loc. cit., p. 497; Abé, loc. cit., p. 330.
1907. ("July") *Hynobius fuscus* Tago, loc. cit., p. 204, 233, (Nikko, Shimozuke Prov.); Hashimoto, loc. cit., p. 499.
1921. *Hynobius naevius* Abé (part?), loc. cit., p. 329.

TYPE: In British Museum. Adult male, collected by Mr. A. Adams.

TYPE LOCALITY: "China or Japan."

RANGE: From northern extremity of Hondo to the Provinces of Izu and Yamato.

DIAGNOSIS: A *Hynobius* with thick tail, which may be keeled above;

short or very short vomerine series; 11-13 costal grooves; toes usually 5, sometimes 4; grayish brown, marbled with darker, and with light marking on sides.

DESCRIPTION: Cal. Acad. Sci. No. 26685, adult male, Inawashiro, Iwashiro Prov., Hondo, collected by V. Kuhne in 1910.

13 costal grooves; appressed toes meeting; head width 6 in length from snout to vent; head length  $3\frac{1}{2}$  in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 2, 3, 4, 1 in order of length; a tubercle under base of first finger and toe; tail shorter than body, cylindrical at base, flattened at tip; vent a slit forking forwards with a small tubercle in apex; vomerine teeth beginning behind inner edge of nares; a forward, incurving branch of 4 teeth; a branch of 13 teeth running back and in; series separated from its fellow anteriorly by twice length of outer branch, and posteriorly by length of outer branch; length of series equals distance between outer edge of nares to median line plus width of nares; brownish gray, lighter below; heavily mottled with black above, and with dark and light on sides; total length 108 mm., head 15, body 52, tail 41.

Variation: A female, Cal. Acad. Sci. No. 26703, same data, differs in having 12 costal grooves; appressed toes separated by one costal fold, head width  $5\frac{2}{3}$  in length from snout to vent; head length  $3\frac{1}{2}$  in length of body; toes 3, 4, 2, 1, 5 in order of length, fifth well developed vent a simple slit; total length 106 mm., head 15, body 50, tail 41.

A series of 23 specimens from Inawashiro, Cal. Acad. Sci. Nos. 26685-26707, shows that of 12 males two have 13 costal grooves, nine have 12, and one has 11; of 11 females six have 13 costal grooves and five have 12. Four, all females, have the appressed toes separated by one costal fold; the rest have them meeting.

Four have a fold of skin on the sides between the legs as in *Ranodon sibiricus*. One has no fifth toe, one has this toe rudimentary, and four have it shorter than do the remaining specimens.

Two specimens from Hakone differ somewhat.

The male, Cal. Acad. Sci. No. 16020, has 13 costal grooves, two costal folds between appressed toes; rather uniform brownish or pinkish gray above, lighter below; total length 109 mm., head 14, body 50, tail 45.

The female, Cal. Acad. Sci. No. 16019, an adult containing large

eggs, agrees with the male, except that the vomerine series is shorter, equalling in length the distance between the outer edge of the nares and the median line; rather darker, brownish gray, more mottled above and below, but very nearly uniform; total length 91 mm., head 11.5, body 41, tail 38.

In spite of the shorter legs, slightly shorter head, and paler color I regard these as the same species as the Inawashiro ones.

An adult female from Inawashiro, containing large eggs, Cal. Acad. Sci. No. 26697, measures 96 mm.

I refer to this species larvae from Northern Hondo which agree in general appearance with larvae of *retardatus* differing in the absence of the dark band on the sides and of the circular spots on the tail.

If my opinion that *peropus*, *nebulosus* as described by Stejneger, *lichenatus*, *nigrescens*, and *fuscus* are the same is correct, the following are additional variations.

The tail may be longer than head and body (*nebulosus* Stejneger, *nigrescens*, *fuscus*), the vomerine series may be somewhat shorter than in the female from Hakone (*lichenatus*), the animal may reach a total length of 135 mm. (*nebulosus* Stejneger), 150 mm. (*nigrescens*), or 160 mm. (*fuscus*).

HABITS: I quote from Tago (1907) his passages concerning the habits of this animal in the region around Nikko.

"Shobu Beach is that part of Lake Chuzenji where the Yugawa River joins the lake. There is an inlet leading to an ice-pond at this point, which I happened to pass during a rain in late October, 1904. The trees were completely bare after a storm the previous day and the foliage everywhere was under my feet instead of over my head. I saw a small dark creature moving among the leaves in the inlet and caught three large, fat monsters measuring 16 cm. each and after careful search found two more of the same size which probably go out into the lake in the spring to breed.

"Tada Lake, which has many streams entering it but no outlet, is located north of Yumoto where I kept my headquarters for this research. Most of my time from early morning until night was spent around this lake which is situated between Onsen Cliff and the back of Yumoto Mt. Evidently volcanic action some generations ago has closed one end of the valley and streams from every direction have gathered to make a lake at this point. It is elongated, lying at the foot of the mountain and at one end the water is very deep, gradually becoming shallow and narrow at the other end which is dammed up. At this shallow end an uninterrupted growth of firs and spruces makes



the water dark even in daytime, and here and there branches fallen in heavy snowstorms check the course of the stream and the water spreads over sandy places and is barely deep enough to cover one's heels.

"It was the middle of July, 1903, and the water was warm and filled with moss and weeds just washed from the mountain-side, and I happened to notice an abundance of tadpoles and caught some more from curiosity than with a view to studying them.

"There were two sorts of tadpoles among them; one small and with small gills was *Bufo*, and the other large and brown with triple gills proved to be *Hynobius fuscus*, which I discovered later from my experience.

"I caught several of the latter, some of which I preserved and others I put into water in order to feed them with algae and egg yolk. About three months later these lost their gills and became land animals, while those in the lake reached their fullest development in August and toward the end of September they lost their gills and in every rain they came on land and went into the bushes.

"Suganuma is a large lake about ten miles round located in a thick wood on the way from Nikko to Joshu by way of Nonjo summit. It is about 3000 feet above sea-level and the temperature there very seldom goes above 16 degrees even on the hottest summer days. The lake runs down to Katashinagawa, a branch of the Tone, and the other end, which has been dammed with rocks and sand, may have been a case of volcanic action on Mt. Shirane.

"Like most of the lakes in this region, running along a valley, it has considerable variation in its width, and is generally divided into three sections with different names; Irinuma (entrance of the lake); Nahanuma (middle section); Kitamata (northern section). The last extends from north to south, the other two run east and west.

"In the middle of July, 1903, I came here for the first time in search of specimens and found eggs of *Hynobius fuscus*. It was at the northeast corner of Irinuma, where the Kiyomizu river enters the lake. I was fishing with a net and saw something white in the water about three or four feet down which looked like a sinker hanging on a fallen tree near the beach, and when it was taken from the water there were 30 or 40 eggs surrounded by a gelatinous mass which appeared like a bunch of cotton batting. The eggs were rather flat, and bicolored, brown and yellowish brown. The former was animal pole and the latter yolk. The gelatin like the wings of a bird formed two connected bags. As I was familiar with the description of *Hynobius fuscus* by



Mr. S. Ikeda in a previous volume I knew they were their eggs, and convinced myself by rearing them that they were the same species as the tadpoles I studied at Tada Lake.

"There are two natural hatcheries of this animal at Suganuma, besides the place just mentioned, one in Nahanuma, and the other at the southeastern corner of Kitamata.

"The adults of this species are found at Ojiri on Kitamata, and on the south shore of Nahanuma, where the beach faces to the west. They live along the lake, generally from three to five feet from the water so that floods do not disturb them, under rocks or decayed trees, and seem to live in colonies although they are often found singly.

"They generally protect themselves from attacks of enemies very cleverly, with more than two entrances or holes into their dwelling place, and make so many passage ways in the ground that in case of attack they can hide or escape. However when the rock or log that covers their place is suddenly removed they simply shrink and try to hide by putting only their head under rocks or in the ground while their body is utterly exposed so that we can easily catch them.

"They go out near the water at night for food, which consists of worms, insects, eggs of tiny animals, fishes and their eggs, and so forth, while the larva eats both animal and vegetable food; algae that grow on dead leaves and bushes in the water, copepods and frog tadpoles and larval insects.

"In May after the snow is gone from the mountain sides at Nikko they come out of their winter retirement to the lake to breed. The breeding takes place in the darkness of night and cannot be described. In summer they stay around the lake or hunt for food along the valleys, so that we can catch them by moving rocks or piles of dead leaves. They retire late in September or early in October for a long winter rest under decayed trees, in the ground or under piles of dead leaves. Sometimes they go many feet deep into the ground following along tree roots.

"The hatching process is similar to that of *H. naevius*. Sometimes a green alga gets into the eggs."

REMARKS: This animal is related on the one side to *H. leechii* of Korea and on the other to *H. retardatus* of Yezo.

The Yezo form is sufficiently specialized to be quite distinct but the Korean form is quite close, and the color is perhaps the most trustworthy feature by which they can be separated. The lichen-like light patches on the sides of *peropus*, and the absence of marked dark spotting on light ground on the back is quite different from the state

of affairs in *leechii*. Unfortunately *leechii* varies far more in color than does *peropus* but in all its variation it never reproduces the coloration of its ally in Hondo.

This is beyond question the form described almost simultaneously by Tago as *fuscus* and by Stejneger as *nigrescens*. That the two were the same was admitted by Tago, and the two type localities, Nikko and Sendai, are mentioned by both authors.

The range of variation in the specimens I have seen covers the descriptions of *lichenatus* and of *peropus*. Tago with his large series and wide field experience could find no specimens of these two forms and regarded them as very doubtfully distinct. He says "the only difference between *fuscus* and *lichenatus* is the rudimentary fifth toe of the latter." This is a purely individual variation, as series of several species of *Hynobius* show, although three forms apparently always have only four toes. I refer Abé's "abnormal" specimen of "*naevius*" from Gumma to this form. It had short vomerine series, and a long tail.

Stejneger's specimen of *nebulosus* from Nikko had 13 costal grooves, thus differing from his specimen of *nigrescens* from Nikko which had 11 costal grooves. As the Inawashiro series shows, this is individual variation. I have examined this Nikko specimen of "*nebulosus*" (Tokyo Col. Sci. No. 51) and find that it is unquestionably the present form. Boulenger (1882), and Okada (1891) record *H. nebulosus* from Nikko, Sternfeld (1916) records it from Shimosuke and Abé (1921) from Shinano. All four doubtless refer to the present form.

Besides the localities mentioned in the list of specimens, it has been recorded from the following places:

Hondo: Mottsu Province: Aomori (Boulenger 1883, *lichenatus*).

Rikuzen Province: Sendai (Stejneger 1907, *nigrescens*; Tago 1907, *fuscus*).

Ozen Province: Shonai (Abé 1921).

Echigo Province: (Abé 1921).

Hida Province: (Abé 1921).

Ishikawa Prefecture: (Abé 1921).

Gumma Prefecture: (Abé 1921).

Kotsuke Province: Lake Suganuma (Tago 1907, *fuscus*).

Shinano Province: Mt. Togashi (Tago 1907, *fuscus*).

Yamato Province: (Stejneger 1907, *peropus*).

Specimens seen: 39, as follows;

Hondo: Rikuoku Province: Mimaya, 7 larvae (Cal. Acad. Sci. 26716, 25395a-f); Ozorezan, 1 larva (Cal. Acad. Sci. 26708).

Rikuzen Province: Shiogama, 5 larvae (Cal. Acad. Sci. 25669a-e).

Iwashiro Province: Inawashiro, 23 (Cal. Acad. Sci. 26685-26707).

Shimozuke Province: Nikko, 1 (Tokyo Col. Sci. 51).

Izu Province: Hakone, 2 (Cal. Acad. Sci. 16019-16020).

MEASUREMENTS OF *Hynobius peropus*.

\* = costal grooves / = costal folds between appressed toes  
 a = 5th toe rudimentary b = vomerine series short  
 c = 5th toe short d = 5th toe absent  
 e = fold of skin on side

Specimen	Locality	Sex	Total length	Head	Body	Tail	*	Remarks
Brit. Mus.	?	♂ a	109	12	47	50		<i>peropus</i> Type
"	Aomori	bc	74	9	29	36	11/	<i>lichenatus</i> "
Tokyo Coll. Sci.	Sendai	♂	150	20	54	76	11/	<i>nigrescens</i> "
"	"	♀	108	15.5	43.5	49	11/	" paratype
"	"	♂	135	16	57	62	13/0	<i>nebulosus</i>
			146	19	61	88	13/	Stejneger 1907
								<i>fuscus</i> , averages
								Tago 1907
	Sendai	♂	126	15	52	59	11/0	Abbé 1921
	"	♂	127	17	53	57	11/0	"
	Shinano		120	15	49	56	12/0	"
	Shonai	♀	111	14	47	50	11/0	"
	Ishikawa		123	16	50	57	11/0	"
	Hida	♀	130	19	53	58	11/0	"
	Echigo	♀	115	16	45	53	11/0	"
	Gumma	?	115	15	50	50	13/	"
Cal. Acad. Sci.								
16019	Hakone	♀ b	90	11	41	38	13/2	
16020	"	♂	109	14	50	45	13/2	
26707	Inawashiro	♂ a	101	15	48	38	11/0	
26706	"	♂	98	14.5	46.6	37	12/0	
26705	"	♀	100	14.5	35.5	40	12/0	
26704	"	♀	101	14	46	41	13/0	
26703	"	♀	106	15	50	41	12/1	
26702	"	♀	99	14	45	40	13/0	
26701	"	♀	86	13	45	28	13/0	
26700	"	♂	89	13.5	42.5	33	12/0	
26699	"	♂ c	81	12	38	31	12/0	
26698	"	♀ e	94	14	44	36	12/0	
26697	"	♀	96	14	45	37	13/1	contains large eggs
26696	"	♀	97	13.5	49.5	34	13/0	
26695	"	♀	100	14	47	39	12/1	

Specimen Cal. Acad. Sci.	Locality	Sex	Total length	Head	Body	Tail	*	Remarks
26694	Inawashiro	♂	105	14	49	42	13/0	
26693	"	♀	90	13.5	41.5	35	12/0	
26692	"	♂c	85	15	43	27	12/0	
26691	"	♂c	107	15	49	43	12/0	
26690	"	♂	95	14	42	39	12/0	
26689	"	♂e	96	14	44	38	12/0	
26688	"	♀c	93	13	49	31	13/1	
26687	"	♂e	106	15	58	43	12/0	
26686	"	♂	101	14.5	47.5	39	12/0	
26685	"	♂d	108	15	52	41	13/0	
26708	Ozorezan	larva	34	7	21	6	12/0	
26716	Mimaya	"	51	8	22	21	12/0	
25395	"	"	49	7.5	21.5	20	12/0	
25395	"	"	50	8	22	20	12/0	
25395	"	"	39	6	15	18		
25669	Shiogama	"	35	6	14	15		
25669	"	"	30					

#### HYNوبيUS RETARDATUS Dunn.

1892. *Hynوبيus nebulosus* Slater Batr. Indian Mus., p. 36 (Yezo).  
 1907. *Hynوبيus fuscus* Tago, (part), Tokyo Zool. Mag., 19, pp. 204, 233.  
 1910. *Hynوبيus lichenatus* Hatta, Tokyo Zool. Mag., 22, p. 88; Hashimoto, 1910, Tokyo Zool. Mag., 22, p. 497; Kuhne, Hatta, and Hashimoto, 1910, Tokyo Zool. Mag., 22, p. 559; Abé 1921, Tokyo Zool. Mag., 34, p. 320; Inukai 1922, Journ. Coll. Agric. Hokkaido Imp. Univ., 10, 5, p. 107.  
 1910. *Hynوبيus nigrescens* Hashimoto, loc. cit., p. 497.  
 1923. *Hynوبيus retardatus* Dunn, Proc. California Acad. Sci., (4), XII, 2, p. 27.

TYPE: Cal. Acad. Sci. No. 35928, recently transformed male, collected Aug. 30, 1911, by Kuhne.

TYPE LOCALITY: Noboribetsu, Iburi Province, Yezo.

RANGE: Island of Yezo.

DIAGNOSIS: A *Hynوبيus* with long, flat tail, very short series of vomerine teeth; 11-12 costal grooves; toes five, long; grayish brown, a darker lateral stripe; reaching a large size before transforming.

DESCRIPTION: Cal. Acad. Sci. No. 35928, Noboribetsu, Yezo, recently transformed, male. Costal grooves 12; appressed toes overlapping; head width 5 in length from snout to vent; head length 3 in length of body; head a blunt oval from above; eye as long as its

distance from tip of snout; lower eyelid fitting under upper in front and behind; upper jaw straight as seen from side; angle of jaw back of hind angle of eye; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes long, 3, 4, 2, 1, 5 in order of length; a tubercle at base of first finger and toe; tail longer than body, flattened, finned above; vent a longitudinal slit; vomerine teeth in two arched series convex forwards, about 17 in series, beginning behind outer edge of nares, curving forward and in to meet its fellow, not curving back at all in median line; grayish brown, a darker lateral stripe, lighter below.

Total length 103, head 15, body 43, tail 45.

Variation: Cal. Acad. Sci. No. 35927, same data, recently transformed male; head width  $5\frac{1}{2}$  in length from snout to vent; head length  $3\frac{2}{3}$  in length of body; angle of jaw under hind angle of eye; tail shorter than body; vomerine teeth in two arched series between nares, 13 teeth in series, on right side a row of 5 teeth behind nares; dark brownish above, lighter below.

Total length 96, head 12, body 44, tail 40.

A recently transformed female (?) Mus. Comp. Zool. No. 5122, Yezo, is similar to the described specimens; the vomerine teeth are in two arched series between the nares, about 12 teeth to a series, series meeting in median line, not extending back of nor in front of nares.

Total length 89, head 13, body 39, tail 37.

Larvae: These are brownish above with black spots; on the tail there are a few circular black spots; sides light with dark marbling; belly light; dorsal fin to middle of back; no fold of skin along leg.

Cal. Acad. Sci. No. 25982-9, Sapporo, Yezo.

25982	total 45	head 8	body 24	tail 13
25983	" 54	" 8	" 23	" 23
25984	" 50	" 7	" 23	" 20
25985	" 38	" 8	" 21	" 9
25986	" 55	" 9	" 24	" 22
25987	" 35	" 8	" 20	" 5
25988	" 60	" 9	" 26	" 25
25989	" 30	" 8	" 22	

Nemuro, Yezo, Cal. Acad. Sci. 25990, total 41, head 7, body 19, tail 15.

This specimen has 5 toes on one side and 4 on the other. All these larvae have the appressed toes meeting and 12 costal grooves.

An adult male, U. S. Nat. Mus. No. 64902, Kutara Lake, Iburi

Province, has 11 costal grooves, the vent is Y-shaped, the vomerine teeth are in adult form for *Hynobius*, consisting of an outer branch of 6 teeth making a right angle with an inner branch of 10 teeth, series separated from its fellow by width of nares, extending further back in the middle than on the sides, length of inner branch not equalling distance between outer edge of nares to median line; total length 134 mm., head 18, body 45, tail 48.

Abé (1921) gives measurements of two adult males from Sapporo:

Total length	110	head	15	body	45	tail	50
"	140	"	19	"	55	"	66

A large larva, U. S. Nat. Mus. No. 64903 from the estuary of the Shirisetunai River, near Lake Shikotsu, Iburi Province, agrees with the Cal. Acad. Sci. specimens. Total length 102 mm., head 14, body 43, tail 45.

REMARKS: The specimens I have examined from Yezo are all one species and this species is very distinct from any of the Hondo *Hynobius* I have seen.

None the less it has been considered to be *fuscus*, *lichenatus*, or *nigrescens*. Irrespective of whether one considers, as I do, that *lichenatus*, *fuscus*, and *nigrescens* are all synonyms of *peropus*, or not, there are good reasons why this Yezo animal cannot be identified with any of them.

In the first place *lichenatus* was described from a fully developed specimen 74 mm. long. This is a length at which the Yezo animal is still a larva. The color of *lichenatus* as described by Boulenger is very different from that of the Yezo form. The toes of *lichenatus* are short. The reasons for identifying the Yezo *Hynobius* with *lichenatus* are the shortness of the vomerine series of *lichenatus*, its 11 costal grooves, and its northern range.

*Nigrescens* as described by Stejneger is a very different animal from the Yezo one; in color, in shape of tail, in length of toes, and in longer vomerine series it is sufficiently different.

*Fuscus* was described by Tago at nearly the same time as Stejneger described *nigrescens*. According to Tago the two are the same. It is hard to believe that his description of Nikko specimens could apply to the present form.

Hashimoto (1910) apparently made no comparison with actual specimens. He came to the conclusion that *lichenatus* and *nigrescens* occurred on Yezo by comparing his specimens with Boulenger's and Stejneger's descriptions. His opinion that he had two species was

apparently not very firm as the next month there appeared "The Reptiles and Amphibians of Hokkaido" by Kuhne, Hatta, and himself, in which only *lichenatus* is recorded from Yezo. Abé (1921) after examining Hashimoto's specimens concludes that there is only one species on Yezo.

My conclusion, then, is that the present form is amply distinct from any of the Hondo species. It may, of course, be proven eventually that two species occur on Yezo, and that the other is the same as one of the Hondo forms, but I take the liberty of expressing polite doubt.

Its relationships are with what I have called *peropus* and are shown in the shortness of the vomerine series, shortness of body, color of larva, and to some extent in the color of the adult. This relationship is rather remote, the fact being that *retardatus* seems to represent an end form, and while *peropus* seems to represent the stock from which *retardatus* was derived, a great deal of differentiation has taken place.

Inukai (1922) says that this animal is neoteinic and "brings offsprings in the larval stage," "as quite recently made known by Dr. Sasaki."

The breeding season of 1922 was April 7-21, and the eggs were laid in long sacs as described for *keyserlingii*, 25-37 in a sac.

Besides the specimens listed below it has been recorded from Kashiuchi and from Yubari, both in the high eastern part of the Hirahara district of Ishikari Province (Hashimoto 1910).

Specimens seen: 14, as follows;

Yezo: no definite locality, 1 (M. C. Z. 5122).

Nemuro Province: Nemuro, 1 (Cal. Acad. Sci. 25990).

Iburi Province: Noboribetsu, 2 (Cal. Acad. Sci. 35927-35928);

Kutara Lake, 1 (U. S. N. M. 64902); estuary of Shirisetunai R., near Lake Shikotsu, 1 (U. S. N. M. 64903).

Ishikari Province: Sapporo, 8 (Cal. Acad. Sci. 25982-25989).

#### HYNOBIUS SONANI (Maki).

1921. *Salamandrella sonani* Maki, Zool. Mag. Tokyo, 34, p. 636.

1921. *Hynobius formosanus* Maki, loc. cit., p. 637 (Mt. Noritaka, 7000 ft. alt., collected May, 1919, by Mr. Sonan).

1921. *Hynobius arisanensis* Maki, loc. cit., p. 637 (Mt. Ari, 6600 ft. alt., collected March 1921, by Mr. Ando).

TYPE: Adult female, collected May 1919, by Mr. Sonan.

TYPE LOCALITY: Mt. Noritaka, Formosa, at altitude of 10,000 ft.

RANGE: Mountains of Formosa.

DIAGNOSIS: A *Hynobius* with very long vomerine series; tail tapering; 12-13 costal grooves.

DESCRIPTION: (I endeavor to combine Maki's remarks about these Formosan salamanders in such a way as not to obscure the points which he considers to differentiate his three species). Head round, flattened; nostril nearer tip of snout than eye (*formosanus*, *arisanensis*); nostril equidistant between eye and tip of snout (*sonani*); distance between nares greater than between eyelids; eyelid longer than interorbital space (*sonani*); eyelid equal to interorbital space (*formosanus*); eyelid almost equal to interorbital space (*arisanensis*); costal grooves 13 (*sonani*), 12 (*formosanus*, *arisanensis*); vomerine tooth row equals  $\frac{3}{4}$  width of tongue (*formosanus*),  $\frac{2}{3}$  (*sonani*),  $\frac{1}{2}$  (*arisanensis*); inner rows close together in *formosanus*, well separated in *arisanensis*, intermediate in *sonani*; fifth toe absent (*sonani*), rudimentary, tubercle-like (*arisanensis*), smaller than first (*formosanus*); "yellow with round dark spots on back and sides" (*sonani*); "tawny yellow, brown spots, small spots on belly" (*formosanus*); "dark brown, with small yellowish-brown spots, somewhat cream colored on belly" (*arisanensis*);

total length	113	head	16	body	50	tail	49	male	<i>arisanensis</i>
"	107	"	15	"	48	"	44	"	"
"	98	"	13	"	45	"	40	female	<i>formosanus</i>
"	90	"	13	"	41	"	36	"	<i>sonani</i>

REMARKS: Maki had four salamanders from Formosa. On these he established three species. His characters appear to me individual variation. The males (*arisanensis*) are much darker than the females (*formosanus*, *sonani*), thus agreeing with the species from Tsu-shima South, etc. In any single character his four specimens form a rather graded series. I have put the description in such a way, however, that others may apply the criteria he used.

The relationships of this form would seem at first sight to be with the *naevius* group. It is more probable, however, that it has been derived independently of that series of forms from some mainland species, especially as the general affinity of the Formosan fauna is far greater for the Chinese forms than for the Japanese. I should not be surprised at the discovery of an animal of the *naevius* group on the mainland, for it is very difficult to derive it from *leechii*. In this case the resemblances would be explained without recourse to parallelism, or to migration from Formosa to Kiusiu.



## HYNOBIUS STEJNEGERI Dunn.

1896. *Hynobius naevius* von Martens, Preuss. Exped. Ost.-Asien, Zool., I, p. 384; Stejneger, 1907, U. S. Nat. Mus. Bull., 58, p. 26, ff. 17-22; Abé 1921, Tokyo Zool. Mag., 34, p. 329.
1923. *Hynobius stejnegeri* Dunn, Proc. California Acad. Sci., (4), XII, 2, p. 28.

TYPE: U. S. Nat. Mus. No. 23901, adult female, collected by Mr. Nakagawa, 1884.

TYPE LOCALITY: Kumamoto, Province Higo, Kiusiu.

RANGE: Kiusiu.

DIAGNOSIS: A *Hynobius* with short, thick tail; very long vomerine series; 13-14 costal grooves; 5 toes; light markings present on whole surface of body.

DESCRIPTION: U. S. Nat. Mus. No. 23901, adult female, Kumamoto, Kiusiu; 14 costal grooves; 3 costal folds between appressed toes; head width 6 in length from snout to vent; head length  $3\frac{1}{2}$  in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 1, 4 in order of length; toes 3, 4, 2, 5, 1 in order of length; a tubercle under base of first finger and toe; tail shorter than body, thick throughout, ending bluntly, somewhat flattened in distal half; vent a simple slit; vomerine series beginning behind inner edge of nares, a forward incurving branch of 6 teeth, a branch of 18 teeth running straight back and a little in, separated from its fellow by about length of outer branch, length of inner branch equalling distance from outer edge of one naris to inner edge of the opposite naris; chocolate brown, lighter below; thickly marbled with largish lighter blotches, which have a reddish brown tinge on the back and are white on the sides and the belly; total length 87 mm., head 14, body 47, tail 26.

Variation: Stejneger (1907) mentions two other specimens in the collection of the Science College, Tokyo. One of these had 13 costal grooves, and total length 107 mm., head 14, body 44, tail 49. It was "paler (more faded?) with less coarse marblings, . . . and the underside nearly uniform pale brownish." These came from the same locality as the type. Abé (1921) gives measurements of two additional specimens.

Chikusen	♀	Total length	122	head	17	body	62	tail	43	14 costal grooves
Kumamoto	?	"	96	"	14	"	46	"	36	13 " "

REMARKS: This animal has been considered the same as *H. naevius*. But the constant difference in color is amply sufficient to distinguish the Kiusiu form. It is doubtless close to *naevius*, and with it and the Hida species, *H. kimurai*, they form a very natural group of vicarious forms. In color *kimurai* and *stejnegeri* are almost identical, but *kimurai* has only four toes, a longer series of vomerine teeth and a longer body.

The record of von Martens (1876) for *naevius* from Nagasaki doubtless refers to the present form. Abé (1921) records it from Chikusen Province.

Specimens seen: one, the type.

#### HYNOBIUS NAEVIUS (Schlegel).

1838. *Salamandra naevia* Schlegel, Fauna Japonica, Rept., p. 122, pl. 4, ff. 4-6, pl. 5, ff. 9-10; 1844, Abbild. Amphib., p. 122, pl. 39, f. 4; Wiedersheim, 1876, Morph. Jahrb., 2, p. 428 (extremities).  
 1838. *Pseudosalamandra naevia* Tschudi, Mem. Soc. Sci. Neuchâtel, pp. 56, 91.  
 1838. *Pseudosalamandra naevia* Tschudi, Classif. Bat., pp. 56, 91.  
 1839. *Molge naevia* Bonaparte, Icon. Fauna Ital., 2, fasc. 26.  
 1854. *Ellipsoglossa naevia* Duméril and Bibron, Erpet. Gén., 9, p. 99, pl. 101, f. 5; Wiedersheim, 1877, Morph. Jahrb. 3, p. 417, pl. 23, f. 64-67, (skull and Hyobranchial apparatus); Druner, 1904, Zool. Jahrb., 19, p. 665, pl. 25 (Hyobranchial apparatus).  
 1859. *Hynobius naevius* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 125; Boulenger, 1882, Cat. Bat. Grad. Brit. Mus., p. 32; Namie, 1903, Tokyo, Zool. Mag., 15, p. 286; Tago, 1904, Tokyo Zool. Mag., 16, p. 44; Stejneger, 1907, Bull. U. S. Nat. Mus., 58, p. 26, pl. 3, ff. 1-3; Tago, 1907, Tokyo Zool. Mag., 19, p. 200, 229.

TYPE: In the Rijksmuseum, Leiden, collected by Siebold. (No type was specified and specimens from the original series have been widely distributed).

TYPE LOCALITY: Mountainous parts of Hondo and Shikoku.

RANGE: Hondo (more specifically from Uso to Kazusa and to Shimozuke, 0-1500 ft. alt.); Shikoku.

DIAGNOSIS: A *Hynobius* with short, thick tail; very long vomerine series; 14 costal grooves; 5 toes; light markings only on sides and belly.

DESCRIPTION: Mus. Comp. Zool. No. 7365, adult female, (Cotype, ex. Leiden Museum via British Museum), "Japan," 14 costal grooves; 2 costal folds between appressed toes; head width 6 in length from

snout to vent; head length  $3\frac{1}{2}$  in length of body; head a broad oval; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 1, 4 in order of length; toes 3, 4, 2, 5, 1 in order of length; a tubercle under base of first finger and toe; tail shorter than body, thick throughout, ending bluntly, somewhat flattened in distal half; vent a simple slit; vomerine series beginning behind inner edge of nares; a forward incurving branch of 8 teeth; a long straight branch of 27 teeth extending back and slightly in; one tooth on each side in from hind end of series separated from its fellow by half width of nares; series separated from its fellow by length of outer branch anteriorly, and by width of nares posteriorly; length of inner branch equalling distance between outer edge of one naris and the inner edge of the other; blackish, on sides and beneath with large whitish marblings; total length 123 mm., head 18, body 64, tail 41.

Variation: I append some measurements taken from Boulenger (1882) and from Stejneger (1907). These are in all probability from animals of the original series.

Brit. Mus.	male	total length	131	head	14	body	64	tail	53
"	female	"	122	"	14	"	60	"	48
Copenhagen	34	"	116	"	16.5	"	54.5	"	45
"	35	"	128	"	19.5	"	60.5	"	48
"	36	"	143	"	18.5	"	63.5	"	64

HABITS: I quote the following from Tago (1907).

"In less elevated regions from the coast to 500 meters above sea level, wherever there is a valley, stream, or pond surrounded by hills and cliffs with cedar, elm, or chestnut trees, we can trace their haunts among moss, dead leaves around swamps, in bushes, under roots, rocks, or in deserted nests of water rats or moles. In short they like damp, shady places where they are free from sunshine.

"It is hard for us to find them among trees or rocks, but after heavy summer rain storms we can very often find them picking up worms and insects driven out of the ground, or sometimes they are caught by a net in the river where they are driven out themselves by the flood.

"When a *Hynobius naevius* is fully grown it starts a life on land and at night, in rain, or on damp days it goes out of its hiding place after food; which consists of worms, insects, and tiny fishes. It enjoys this life all through summer until late in the fall, and about October

it retires for a long winter rest, hiding himself in the ground near water. Once I found one of them in this concealment in a cave six inches deep in the ground by a spring in a cedar grove.

"Early in March, on coming out of a long hibernation it takes up a strenuous life again. The first thing it does is to seek its mate, going along water-ways, and looking for a suitable place for breeding its offspring. They seem to be very particular in the selection of such a place as we very often find several of them in one place at this season, which is the latter part of March.

"March 2nd, 1904, at 8.30 in the morning, I found a group of their eggs in a small pond under a cedar grove which covered a low cliff called Takanosu of Iwabune, Tochigi Prefecture. The lower bushes were mostly of Yamabuki and of young elm trees, and the water was  $9\frac{1}{2}$  inches deep and the pond was open to the north. There were some thirty or forty eggs contained in a transparent gelatinous mass shaped like a lead weight [sinker] with both ends bent in and attaching to the twig in the pond, and measuring 60 mm. in diameter.

"The eggs varied in size from 2.5 to 3 mm. in diameter, and their animal poles were yellowish brown, and the vegetative poles were yellow.

"Also I found two groups of eggs with their mother under dead leaves not far from the same place in a narrow ditch 6 inches wide in rice fields (swamp).

"In a shallow stream hardly 3 inches deep, running to the north through bushes among young cedar trees I found another two groups with their mother. Most of the eggs were out of water and were in an early stage of development.

"In a narrow stream, hardly above our heels and about a foot wide, that ran northeast through dark bushes in a wood I found another two groups with eleven adults. There were many chestnut, elm, etc., with a few cedar trees in the woods.

"In a spring beneath large cedar trees, (the upper part full of clear water that runs some distance into a narrow stream, and the lower, which is wider and swampy, being dug out in connection with the spring for rice growing), I noticed many egg-masses, and after taking out twenty buckets of water I found them hung on dead branches and roots. Toward the center, where the water was deeper I noticed that the eggs were supported by a large cedar branch in such a way that they would not sink deeper than 6 inches. Many eggs and several adults were the result of my efforts.

"A score of large cedar trees at Iwabune shrine always keep the

yard in shade, and there is a large stone bowl inside the wooden fence. This bowl is filled with water by occasional rains and in the fall by dead leaves. Here I found a quantity of eggs with the mother.

"Shakutakano in Ibaraki Prefecture is indeed a place of natural beauty. Hill after hill of considerable height contrasts with valleys winding far below, and a crystal stream echoes through the region. A mile upstream, the valley becomes narrow and the water scanty, and large rocks and trees here and there make the place dark. There is a tree there which gives a queer uncomfortable odor, and there I found many egg-masses, some of which were just out of the cloaca of the mother, and the sack which contains them was wrinkled up instead of stiffened by assimilated water.

"The eggs hatch after 12-15 days. After 15-16 days the larva grows more lively and comes out from a corner of its shell, or sometimes it breaks the shell in the center. It is then about 15 mm. long. On both sides of the cheeks it has double balancers, and triple external gills, but mouth and gill slits do not open at this stage. There is a stump which later becomes the front leg. The tail is about half as long as head and body, and has a fin above and below, the upper fin reaching the middle of the body. It is yellowish brown above and yellow below. There are brown spots. It holds on to things by means of the balancers. About ten days after hatching the front legs begin to grow, at first oar-shaped, the middle part gradually increasing. It takes fourteen days before the hind legs begin to develop. Next, mouth and gill slits open, and the gills grow large and long.

"Probably in August or September the metamorphosis takes place and land life begins."

REMARKS: This strongly marked form is related only to *kimurai* and to *stejnegeri*. Of these *stejnegeri* is marbled with lighter both above and below; *kimurai* is marbled above and on the sides, the belly being uniform; *naevius* is marbled on the sides and the belly, the dorsal surface being immaculate.

Tago (1907) records this animal from parts of Hondo north of Tokyo, as follows: Uso Province, Kariwano; Iwashiro Province, Hautayama; Shimozuke Province, Tochigi Machi, Iwabune; Fukushima Prefecture, Ogawa; Ibaraki Prefecture, Shakutano; Kazusa Province, Koshikiya.

Okada records it from Kyoto, but this probably refers to *kimurai*, and the reference has been placed in the synonymy of that species.

Mention will be made below of larvae from Miyazu, Tango Province, doubtfully referred to *kimurai*. If Tago is correct in his

statement that *naevius* occurs only northward in Hondo, then the Kyoto and Miyazu animals may well be *kimurai*, and I have given them the benefit of the doubt.

Besides Schlegel's original reference, Namie (1903) records it from Shikoku. (Schlegel's type locality for this form is very vaguely given. He says of *naevius* merely that it lives in the same places as *unguiculata* (*O. japonicus*), for which he gives the following: "In abundance in mountainous parts of Nippon and Sikok, especially Sagami, Sinano, Tanba, Tazima, and Tosa." This may or may not be wholly applicable to *naevius*).

Specimens seen: one, cotype. "Japan."

#### HYNOBIUS KIMURAI Dunn.

1891. *?Hynobius naevius* Okada, Cat. Vert. Japan, p. 65; Abé, 1921, Tokyo Zool. Mag., 34, p. 329.  
 1907. *Salamandrella* n. sp. Tago, Tokyo Zool. Mag., 19, p. 237; Maki, 1921, Tokyo Zool. Mag. 34, p. 636.  
 1923. *Hynobius kimurae* Dunn, Proc. California Acad. Sci., (4), XII, 2, p. 27 (typ. err.).

TYPE: Mus. Comp. Zool. No. 8546, adult female. Collected by Dr. Kimura and Dr. H. H. Wilder, 1820.

TYPE LOCALITY: Mt. Hieizan, Omi Province, Hondo.

RANGE: West Central Hondo.

DIAGNOSIS: A *Hynobius* with short, thick tail; very long vomerine series; 13-15 costal grooves; usually 4 toes; brown, with light flecks over dorsal surface.

DESCRIPTION: Mus. Comp. Zool. No. 8546, adult female, Mt. Hieizan, Hondo; 15 costal grooves; 4 costal folds between appressed toes; head width 6 in length from snout to vent; head length  $3\frac{3}{4}$  in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers short, 2, 3, 1, 4 in order of length: toes 3, 4, 2, 1 in order of length; a tubercle under base of first toe and finger; tail shorter than body, thick throughout, ending bluntly, slightly flattened in last half; vent a simple slit; vomerine series beginning behind inner border of nares, a forward incurving branch of 5 teeth, a branch of 17 teeth running straight backwards, not meeting its fellow, separated all along by width of

nares, length equalling distance between outer edges of nares; bluish brown above, lighter below; small light flecks over whole dorsal surface: total length 121 mm., head 17.5, body 65.5, tail 39.

Variation: A male, Cal. Acad. Sci. No. 27258 Hida Province, Hondo, differs in having 14 costal grooves; 3 costal folds between appressed toes; head width 5 in length from snout to vent; head length  $3\frac{2}{3}$  in length of body; vomerine series beginning behind middle of nares; main branch S-shaped, of 25 teeth, meeting its fellow behind; length equalling distance between outer edges of nares plus width of nares; total length 108 mm., head 15, body 51, tail 42. Tago (1907) gives averages of 13 males and 22 females from Takaramura, Yoshishiro district, Hida Province, as follows:

Male	Total 110	head 15	body 50	tail 45
Female	" 105	" 14.5	" 47.5	" 43

I refer the three specimens of *H. naevius* mentioned by Abé (1921), from Western Hondo to this species, not without misgivings. The Etchu specimen had 4 toes. Measurements as follows:

Etchu Prov.	♀	total 120	head 14	body 56	tail 50	13 costal grooves
Fukui Pref.	♀	" —	" 14	" 47	" —	13 " "
Gifu Pref.	?	" —	" 15	" 53	" —	13 " "

Maki (1921) says "recently Prof. Watase found one at Kuroba, Toyama."

I refer two larvae, Cal. Acad. Sci. No. 16322-3, from Miyazu, Tango Province, Hondo, to this species with considerable doubt. They may belong to *H. naevius*. They have 13 costal grooves and one costal fold separates the appressed toes. They have four toes. The color is rather light brown with two black cross-bands on body, one just back of legs, and two or three on tail.

16322	Total 48	head 6	body 20	tail 22
16323	" 35	" 4	" 16	" 15

Tago (1907) says that in his series, referred to above, one out of twenty has five toes.

HABITS: According to a letter from Mr. Yasutaro Mayeda, quoted by Tago (1907), the habits at Kami, Takaramura, Yoshishiro district, Hida Province, are as follows: "Above the reservoir where the stream is 6-7 feet wide and 6-7 inches deep there is a small spring near the foot of the mountain. About three weeks of every year the animals gather round this spring by hundreds from every direction to breed



in the water. During the summer they go into the mountainside and seek damp places under bushes or fallen trees, and through fall, winter, and spring they burrow and are very seldom seen. Thus it is easy to catch twenty of them in the breeding season while it is hard to get even a few at other times of the year. They are called Oka Imori (Land Lizard) in this part of the country." The breeding season is not definitely stated but is evidently spring.

REMARKS: This animal is close to *H. naevius* but quite distinct. In color it resembles rather *H. stejnegeri* from Kiusiu. Tago intended to describe it as new, but I have been unable to find that he ever did so.

It is apparently a mountain form and ranges south and west of *H. naevius* which is according to Tago restricted to low altitudes in Northern Hondo. The larvae from Miyazu are quite a problem. Tago (1907) records *naevius* from Kariwano, Uso Province on the west coast. If altitude is the distributional factor involved the Miyazu specimens might well be *naevius*, and they agree with *naevius* in proportions rather than with *kimurai*. But they are well advanced and have only four toes, and in the uncertainty I think it better to leave them with the less known form. I think it probable that the record of *naevius* from Kyoto, (Okada 1891) refers to *kimurai*.

Specimens seen: 4, as follows;

Hondo: Hida Province, 1 (Cal. Acad. Sci. 27258); Mt. Hieizan, Omi Province, 1 (M. C. Z. 8546); Miyazu, Tango Province, 2 (Cal. Acad. Sci. 16322-16323, larvae).

#### HYNOBIUS TAGOI Dunn.

1907. *Hynobius nebulosus* Stejneger (part), U. S. Nat. Mus. Bull., 58, p. 31.

1923. *Hynobius tagoi* Dunn, Proc. California Acad. Sci., (4), XII, 2, p. 29.

TYPE: California Acad. Sci. No. 26563, adult male, collected October, 1910, by Victor Kuhne.

TYPE LOCALITY: Tsu-shima, North Island.

RANGE: Known only from the type locality.

DIAGNOSIS: Vomerine series medium; tail somewhat flattened; 13 costal grooves; toes 5; sides of tail not black; middorsal line of tail not yellow; grayish brown with fine darker brown stippling.

DESCRIPTION: Type; 13 costal grooves; one costal fold between appressed toes; head width  $5\frac{1}{3}$  in length from snout to vent; head length  $3\frac{1}{3}$  in length of body; head an oval from above; eye as long as its distance from tip of snout; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting



under upper in front and behind; a groove from hind angle of eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; a tubercle under base of first finger and of first toe; tail shorter than body, cylindrical at base, flattened at tip, just past level reached by appressed toes trigonal with a low dorsal keel, scarcely widened anywhere; vent a longitudinal slit, slightly forking forwards, so that there is a small triangular flap at apex; vomerine series beginning behind and in from inner border of nares, a short forward and incurving branch of 4-5 teeth, a long straight branch of 17 teeth extending back and slightly in, a short branch of 2 teeth curving in to meet its fellow of opposite side; series separated from its fellow in front by  $1\frac{1}{2}$  length of outer branch, and posteriorly by length of outer branch; length of inner branch equals distance between outer edge of naris and the peak of the opposite vomerine series; brownish gray above, with fine crowded darker stippling, middorsal line of tail slightly lighter; below light, nearly covered with faint gray marbling; total length 116 mm., head 15.5, body 51, tail 49.5.

REMARKS: The specimen mentioned by Stejneger (1907, p. 31) as collected by Holst in Tsu-shima, Oct. 6, 1891, seems to be this form rather than the Tsu-shima South species. He describes the color of the specimen, a female, Brit. Mus. No. 92.1.11.18, as "yellowish brown with numerous obscure dusky spots; underneath uniform pale brownish, this pale effect being produced by a uniform dusting of minute, round, yellowish specks on a dark brownish gray ground."

"Total length 117, snout to vent 68, snout to gular fold 16, vent to tip of tail 49."

This species is a member of the group comprising the animals of Tsu-Shima South, Iki-shima, *nebulosus* of Kiusiu, *vandenburghi* of Hondo, and the undescribed form from Shikoku. From them all it differs in color. I cannot find a match for it in a series of 168 adults from the South island. In that species the sides of the tail are always black, the ground color is yellow, the black spotting is coarse and irregular, and unless the animal is uniform black (as in some old males) the middorsal line of the tail is bright yellow. The Iki-shima form has a shorter head, the color is much darker, although the spots are fine as in *tagoi*, and again unless the animal is uniformly dark the middorsal line of the tail is yellow. *Nebulosus* of Kiusiu is similar to the South Tsu-shima form, but the sides of the tail are not black, while the Hondo form is abundantly distinct by reason of its very flat tail.

Specimens seen: One, the type.

## HYNOBIUS TSUENSIS Abé.

1907. *Hynobius nebulosus* Tago (part), Tokyo Zool. Mag., 19, p. 201, 233;  
Sternfeld 1916, Sitz. Ber. Gesch. Nat. Fr. Berlin, p. 172.  
1921. *Hynobius tsuensis* Abé, Tokyo Zool. Mag., 34, p. 331.  
1923. *Hynobius bicolor* Dunn, Proc. California Acad. Sci., (4), XII, 2, p. 28  
(Tsu-shima, South Island).

TYPE: In Tokyo Zoölogical Museum (?).

TYPE LOCALITY: "Tsu-shima."

RANGE: Known only from Tsu-shima, South Island.

DIAGNOSIS: Vomerine series medium; tail somewhat flattened; costal grooves 13-14; toes 5; sides of tail black; middorsal line of tail yellow; yellow with black mottling; males black.

DESCRIPTION: Cal. Acad. Sci. No. 26447, Type, adult male; 13-14 costal grooves; one costal fold between appressed toes; head width  $5\frac{1}{4}$  in length from snout to vent; head length  $3\frac{1}{2}$  in length of body; head an oval as seen from above; eye as long as its distance from tip of snout; outline of jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; a tubercle under base of first digit of hand and foot; tail as long as body, cylindrical at base, flattened at tip, just past level reached by appressed toes trigonal with a low keel above, scarcely widened anywhere; vent a longitudinal slit, forking forwards so that there is a small triangular flap at apex; vomerine series beginning behind inner border of nares; a short forward and incurving branch of 6 teeth; a long branch of 20 teeth extending straight back and a little inwards; series separated from its fellow anteriorly by  $1\frac{1}{2}$  length of outer branch, posteriorly by  $\frac{1}{2}$  length of outer branch; series extends from level of anterior edge of nares to hind quarter of eye socket; length of inner branch equals distance from outer edge of naris to peak of opposite series; black above, with irregular lighter flecks; middorsal line of tail light; gray beneath; sides of body marbled gray and light; sides of tail black above, shading into gray below; total length 129 mm., head 17, body 56, tail 56.

Variation: A female, Cal. Acad. Sci. No. 26491, same data, differs as follows; 14 costal grooves; 3 costal folds between appressed toes; head width 6 in length from snout to vent; head length  $3\frac{2}{3}$  in length of body; tail shorter than body; vent a simple slit; yellow above with small irregular black spots which tend to connect with each

other; middorsal line of tail yellow; sides of body and of base of tail marbled yellow and black; sides of distal half of tail black; total length 123 mm., head 17.5, body 62.5, tail 43.

A young specimen, Cal. Acad. Sci. No. 26519, same data, has the appressed toes meeting; the coloration is scarcely different from that of the described female; total length 49 mm., head 8, body 21, tail 20.

A larva, Cal. Acad. Sci. No. 26562, same data, has external gills pigmented, and rather flat and wide; the dorsal fin extends a little forward of the middle of the body; pigmentation rather uniform and confined to the dorsal surface, save on the tail which is more coarsely spotted all over; there is a fold of skin along the leg from the fifth toe up; total length 49 mm., head 8, body 20, tail 21.

Among the adults the males have longer tails and the black spotting of the dorsal surface tends to obscure the yellow ground color, by coalescence of the spots. Certain males, e.g. No. 26479, are quite black above. Males also have the legs proportionately longer as do the young. Of 18 males one has the appressed toes meeting, 16 have them separated by one costal fold, and two by two; while of 20 females the appressed toes are separated by one costal fold in two, by two in eight, and by three in ten; of fifteen young ten have the appressed toes meeting, in four they are separated by one costal fold, and in one by two.

A few females are almost as dark as the described male. The costal groove count is 14 in five out of 13 males, 13-14 in one and 13 in the other seven; it is 14 in two out of eleven females and 13 in the nine others.

The fifth toe is rudimentary on the left side in No. 26463, a male; another male, No. 26492 is a partial albino.

These are the only noticeable abnormalities in a series of 184.

REMARKS: I have included two of the three references in the literature to *H. nebulosus* from Tsu-shima in the synonymy of this species. Neither are accompanied by descriptions. The third is accompanied by a description but apparently refers to *H. tagoi* from the North Island.

I think Abé's *H. tsuensis* refers to this form. He says Tago made a plate of it. Tago took it at Iwahara, on the southern island.

The *Hynobius* of South Tsu-shima differs strikingly in color from its close ally *H. tagoi* of North Tsu-shima, resembling rather *H. vandenburghi* of Hondo, from which it can easily be told by the very flat tail of the latter. The black spotting is much coarser than in the forms

from North Tsu-shima, from Iki-shima, and from Kiusiu, and none of these three have the black tail of *tsuensis*.

Specimens seen: 184, as follows;

Tsu-shima, South Island: 183 (Cal. Acad. Sci. 26380-26547, 168 adults: 26548-26562, 15 larvae).

"Tsu-shima" (a specimen of *tsuensis*): 1 (M. C. Z. 5123).

MEASUREMENTS OF *Hynobius tsuensis*.

\* = costal grooves.

/ = costal folds between appressed toes.

Specimen	Locality	Sex	Total length	Head	Body	Tail	*
Cal. Acad. Sci. 26447	Tsu-shima, S. I.	male	129	17	56	56	13-14/1
M. C. Z. 5123	"	?	132	16.5	57.5	58	14/1
Cal. Acad. Sci. 26479	"	S. I.	126	16.5	59.5	50	/1
" 26495	"	"	126	17	58	51	14/1
" 26460	"	"	126	16	57	53	/1
" 26458	"	"	125	15.5	57.5	52	/1
" 26501	"	"	125	17	56	52	/1
" 26467	"	"	125	16	57	52	/1
" 26464	"	"	125	17	55	53	/1
" 26403	"	"	122	16.5	55.5	50	14/2
" 26486	"	"	119	16	55	48	/1
" 26439	"	"	119	15	54	50	14/1
" 26408	"	"	118	17	56	45	13/1
" 26399	"	"	117	16	56	45	13/1
" 26380	"	"	116	16	52	48	14/1
" 26420	"	"	113	16	50	47	13/0
" 26387	"	"	110	15.5	57.5	37	13/2
" 26450	"	"	108	16	50	42	/0
" 26419	"	"	99	14	46	39	13/1
" 26423	"	"	95	13.5	49.5	32	13/1
" 26424	"	"	96	14	46	36	13/1
" 26491	"	female	123	17.5	62.5	43	/3
" 26413	"	"	129	16.5	61	51.5	13/3
" 26414	"	"	126	17	61	48	14/3
" 26429	"	"	125	17.5	59.5	48	13/2
" 26432	"	"	123	17	61	45	13/3
" 26443	"	"	121	16	56	49	/2
" 26466	"	"	119	16	57	46	/3
" 26421	"	"	119	16	52	51	13/1
" 26302	"	"	118	16	62	40	13/3
" 26487	"	"	117	15.5	59	42.5	/3
" 26451	"	"	115	15	54	46	/3

Specimen	Locality	Sex	Total length	Head	Body	Tail	*
Cal. Acad. Sci. 26507	Tsu-shima, S.I.	female	116	17	58	41	/2
" 26513	" "	"	116	17	58	41	/2
" 26404	" "	"	116	16	54	46	13/2
" 26505	" "	"	115	16	55	44	/2
" 26465	" "	"	110	15	57	38	/2
" 26449	" "	"	112	15	53	44	/2
" 26384	" "	"	111	15.5	54.5	41	13/2
" 26405	" "	"	105	14	48	43	13/3
" 26396	" "	"	95	13	44	38	13/1
" 26500	" "	not sexed	100	13.5	45.5	41	/1
" 26454	" "	"	99	14	50	35	/2
" 26459	" "	"	91	14	46	31	/0
" 26498	" "	"	82	12.5	39.5	30	/0
" 26511	" "	"	78	12.5	38.5	27	/0
" 26515	" "	young	77	11	35	31	/0
" 26514	" "	"	74	12	33	29	/0
" 26472	" "	"	65	9.5	29.5	26	/1
" 26473	" "	"	60	10	27	23	/0
" 26534	" "	"	60	9.5	25.5	25	/1
" 26527	" "	"	58	8.5	25.5	24	/1
" 26543	" "	"	57	9.5	27.5	22	/0
" 26536	" "	"	55	9	24	22	/0
" 26519	" "	"	49	8	21	20	/0
" 26480	" "	"	48	8	20	20	/0
" 26562	" "	larva	49	8	20	21	
" 26561	" "	"	44	8	18	18	
" 26560	" "	"	42	8	17	17	
" 26550	" "	"	41	7	17	17	
" 26548	" "	"	41	8	16	17	

## HYNOBIUS IKISHIMAE Dunn.

1923. *Hynobius ikishimae* Dunn, Proc. California Acad. Sci., (4), XII, 2, p. 28.

TYPE: California Acad. Sci. No. 26314, adult male, collected October, 1910, by Victor Kuhne.

TYPE LOCALITY: Iki-shima.

RANGE: Known only from type locality.

DIAGNOSIS: Vomerine series medium; tail somewhat flattened; 13 costal grooves; toes 5; sides of tail not black; middorsal line of tail yellow; grayish brown with black mottling; males darker than females.

DESCRIPTION: California Acad. Sci. No. 26314, adult male; col-

lected October, 1910, by Victor Kuhne, Iki-shima; costal grooves 12; 2 costal folds between appressed toes; head width 6 in length from snout to vent; head length  $3\frac{1}{2}$  in length of body; head oval from above; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from hind angle of eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; a tubercle under base of first finger and of first toe; tail shorter than body, cylindrical at base, flattened at tip, trigonal just beyond level reached by appressed toes, no keel; hind part of tail widened somewhat; vent a slit forking forward so that there is a small triangular flap at apex; vomerine series beginning behind and in from inner border of naris; a short forward-and-incurving branch of 5 teeth, a long straight line of 20 teeth extending back and slightly in; series separated from its fellow by twice length of outer branch in front and by  $1\frac{1}{2}$  times outer branch behind; series reaches posterior border of eyesockets; length of inner branch equals distance from outer border of naris to a point halfway between peak of opposite series and inner edge of opposite naris; uniform dark grayish brown above; lighter below a line joining insertions of legs; tail dark grayish brown above, lighter below, rather bicolored; total length 118 mm., head 15, body 57, tail 46.

Variation: A female, Cal. Acad. Sci. No. 26310, same data, has 13 costal grooves; one costal fold between appressed toes; head width  $6\frac{1}{2}$  in length from snout to vent; head length  $4\frac{1}{2}$  in length of body; vomerine tooth series beginning at level of nares, meeting its fellow behind by an inner branch of two teeth on each side; dull grayish brown above with spots of black; gray below; middorsal and mid-ventral lines of tail bright yellow; total length 101 mm., head 14, body 58, tail 29.

A young specimen, Cal. Acad. Sci. No. 26214, same data, has 13 costal grooves; appressed toes meeting; head width 4 in length from snout to vent; head length  $2\frac{2}{7}$  in length of body; grayish brown with an indication of an irregular dorso-lateral row of black spots and a lateral darker stripe; a bright streak on median line of tail above and below; these bordered by a black streak, and middle of sides of tail lighter; light gray below; total length 38 mm., head 7, body 19.5, tail 11.5.

The males are generally darker, with less prominent tail stripe. The tail is flattest in some males.

Of nineteen males one has 12, one 12-13, fifteen have 13, one 13-14, and one 14 costal grooves. In nine the appressed toes are separated by 2, and in ten by 3 costal folds.

Of twenty females all have 13 costal grooves. In six the appressed toes are separated by 3, and in fourteen by 4 costal folds.

In ten young specimens the number of costal grooves is 13. The appressed toes meet in two, and are separated by one costal fold in two, by two in three, and by three in three.

This indicates a greater relative leg length in the young and in the males.

The fifth toe is lacking in No. 26205, lacking on the right side in 26161, rudimentary in 26207 and 26212, and rudimentary on side in 26156, 26157, 26186 and 26201. This is from a series of 179 in the Cal. Acad. Sci. all with the same data as the type.

The length of the vomerine series is quite constant. The distance between the inner branches is rather variable, as is the meeting posteriorly of the two series.

REMARKS: The species from Iki-shima is closest to the *Kiusiu nebulosus*, both anatomically and geographically. It differs from *nebulosus* in the greater fineness of its black spotting, and in the tail being trigonal in cross section rather than oval as in *nebulosus*. It is, however, very close to it, and as I have seen no specimens of *nebulosus* it may be that I am employing too fine discrimination. However, none of the Iki-shima specimens can be matched by Schlegel's (1838) figure of *nebulosus*, and the present form is certainly distinct from the Hondo and Tsu-shima species, so that I think myself justified in naming it.

Specimens seen: 179, as follows;  
Iki-shima, 179 (Cal. Acad. Sci. 26149-26327).

#### MEASUREMENTS OF *Hynobius ikishimae*.

\* = costal grooves.

/ = costal folds between appressed toes.

Specimen	Locality	Sex	Total length	Head	Body	Tail	*
Cal. Acad. Sci.							
26314	Ikishima	male	118	15	57	46	12/2
26160	"	"	113	15	62	36	13/3
26166	"	"	117.5	15	57.5	45	13/3
26298	"	"	110	15	55	40	13/3
26149	"	"	110	14	56	40	13/2
26316	"	"	109	14	57	38	13/3



Specimen	Locality	Sex	Total length	Head	Body	Tail	*
Cal. Acad. Sci.							
26190	Ikishima	male	105	14	59	32	13/2
26285	"	"	109	15	54	40	12-13/2
26151	"	"	108	15	55	28	13/2
26168	"	"	107	15	52	40	13/2
26281	"	"	107	14.5	51.5	41	13/3
26153	"	"	106	14.5	52	39	13/3
26320	"	"	105	14	51	40	13-14/2
26325	"	"	102	14	51	37	13/3
26319	"	"	98	14	54	30	
26318	"	"	99	13.5	51.5	34	13/3
26200	"	"	101	14.5	48.5	28	13/2
26256	"	"	100	13	49	38	14/3
26321	"	"	93	13	47	33	13/2
26158	"	female	107	14	58	35	13/3
26164	"	"	103	14	49	30	13/4
26310	"	"	101	14	58	29	13/4
26150	"	"	111	13.5	57.5	40	13/4
26257	"	"	111	13.5	57.5	40	13/4
26248	"	"	110	13.5	57.5	39	13/4
26165	"	"	111	14	56	41	13/4
26296	"	"	110	13.5	56.5	40	13/3
26283	"	"	109	15	52	42	13/4
26327	"	"	105	14	55	36	13/4
26292	"	"	105	13.5	54.5	37	13/4
26308	"	"	102	13	55	34	13/4
26312	"	"	100	13	53	34	13/4
26324	"	"	102	14	51	37	13/4
26161	"	"	102	13.5	51.5	37	13/3
26265	"	"	101	12.5	53.5	35	13/4
26155	"	"	97	13	51	33	13/3
26294	"	"	104	13.5	49.5	41	13/4
26305	"	"	102	13.5	49.5	39	13/3
26244	"	"	95	12.5	46.5	36	13/3
26187	"	young	84	11.5	39.5	33	13/3
26277	"	"	83	12	39	32	13/2
26188	"	"	76	12	39	25	13/2
26198	"	"	74	11	37	26	13/3
26171	"	"	68	10	35	23	13/3
26220	"	"	67	10	32	25	13/2
26202	"	"	47	8	33	6	13/1
26206	"	"	53	8	25	20	13/1
26238	"	"	42	7	19	16	13/0
26214	"	"	38	7	19.5	11.5	13/0

## HYNOBIUS NEBULOSUS (Schlegel).

1838. *Salamandra nebulosa* Schlegel, Fauna Japonica, Rept., p. 127, pl. 4, ff. 7-9; 1844, Abbild. Amphib., p. 126, pl. 40, ff. 7-10; Wiedersheim 1876, Morph. Jahrb. 2, p. 428 (carpus and tarsus).
1838. *Hynobius nebulosus* Tschudi, Mem. Soc. Sci. Neuchâtel, pp. 60, 94; Gray 1850, Cat. Bat. Grad. Brit. Mus., p. 30; Boulenger 1882, Cat. Bat. Grad. Brit. Mus. (2), p. 32; Stejneger 1907, U. S. Nat. Mus. Bull., 58, p. 30, pl. 3, f. 4-6; Tago 1907, Tokyo Zool. Mag., 19, p. 201, 233; Kunitomo 1910, Anat. Hefte, 40, p. 193 (habits); 1911, Anat. Hefte 44, p. 457 (embryology); Abé 1921, Tokyo Zool. Mag., p. 330.
1854. *Ellipsoglossa nebulosa* Duméril and Bibron, Erpet. Gén., 9, pl. 100; Wiedersheim 1877, Morph. Jahrb. 3, p. 417 (skull); Edgeworth 1920, Journ. Anat., 54, p. 225, ff. 71-76, (hyobranchial apparatus); 1923, Journ. Anat., 57, p. 97, ff. 11-13 (hyobranchial apparatus).

TYPE: In Leiden Rijksmuseum, collected by von Siebold. (No type was specified and specimens from the large original series are in the British Museum, the Senckenberg Museum and the Copenhagen Museum).

TYPE LOCALITY: "Mits jama" near Nagasaki, Kiusiu.

RANGE: Kiusiu.

DIAGNOSIS: Vomerine series medium; tail flattened; 13 costal grooves; toes usually 5; sides of tail not black; middorsal line of tail yellow; yellow with black marbling; sexes alike in color.

DESCRIPTION: Since I have seen no specimens of this form I quote Schlegel's original description.

"Purely aquatic, this species has some analogy with the black salamander of North America. It is almost as big as the crested salamander, but it is stouter, the head is small and rounded, the feet are less developed and with short fingers, the tail is large, shorter than the body, thick at the base and compressed towards the tip. On the flanks there are very extensive and deep transverse folds, a similar fold surrounds the throat like a half collar. Of a more or less deep brownish yellow, all the upper parts are clouded with deep and very fine marblings; these extend sometimes on the under side. Some have the edges of the tail with a yellow streak, others have the colors very deep; in a word, one observes in this species, just as in most others, many accidental variations. The tongue is very large and long but only free at its edge. The eyes are smaller than usual and directed a little forward. The skeleton much resembles that of *S. naevia*;

the palatine teeth are exactly alike; but there are only 17 trunk vertebrae; and it has a shorter skull.

"I can note no external difference between the sexes; the young, which soon lose the gills, resemble the adults save in size."

Variation: Stejneger (1907) mentions a specimen in the Copenhagen Museum (No. 33) from the original series. This animal, a male, had the fifth toe rudimentary. I append measurements of two males of the original series taken from Stejneger (1907) and from Boulenger (1882).

Brit. Mus.	Total length	99	head	12	body	44	tail	43
Copenhagen Mus. 33	"	95	"	12	"	42	"	41

Abé (1921) records a female from Oita Prefecture. It had total length 128 mm., head 18, body 53, tail 57, costal grooves 13, appressed toes meeting.

HABITS: Schlegel (1838) says "purely aquatic," and that Siebold "saw larvae of this species in a spring at the base of Mt. Ho Kwa San near Nagasaki. They swim with much agility so that one might mistake them at first for little fishes."

Kunitomo (1910) gives an extended account of the breeding habits near Nagasaki, from which I quote the following.

"I knew already in the year 1904 that *Hynobius* was present in the Nagasaki-Yamasatomura Mts., and in the Spring of 1905 I found the pool where every year they lay their thousands of eggs. The mountain on which this pool is found is about 600 m. high and unwooded, although bushes and much grass grows there. The west side is a sheer cliff from the peak down about 150 m., and at the bottom of this cliff lies a pool, which is about 3 m. broad, 4 m. long and 30 cm. deep. So little water reaches the pool from the cliffside, except in continuous rainy weather, that it has no outlet. When it does not rain at all for many weeks it dries up completely."

"*Hynobius nebulosus* belongs to those Urodeles which lay their eggs very early in the Spring, before the other Japanese salamanders, for its spawning time is between March 10 and April 3, while the local *Triton* breeds during May and June, and *Cryptobranchus* during August and September. During the aforementioned period, if the weather progresses so favorably that the animals come out of hibernation, they crawl out here and there and betake themselves to a nearby pool, spring, or brook. According to whether the favorable weather comes earlier or later during the aforementioned period, the animals also appear earlier or later.

"Now March is often so cold in Japan, that frost covers the ground in the morning, and on rare occasions it snows.

"The weather at this season is very variable. . . . Often it turns suddenly warmer and great quantities of rain fall, thereupon the *Hynobius* emerge and seek a pool, where they can spawn, and if these weather conditions endure about three days, egg-laying takes place, even though it turns cold again afterwards. If, however, the cold sets in again after a very short time, before the Liebesspiel has begun, (after about a day), the animals remain motionless at the bottom as if sleeping, and await a second warm rain. If the weather is very unfavorable for their purposes, e.g. if the pool dries up entirely, they crawl back on land and hide themselves in their former dwelling places. If the pool does not dry up, but there comes a second warm rain, then they swim vivaciously hither and thither, newly awaked, and with them others, which have just come in from the land. Then they carry on their Liebesspiel; thereafter they lay the eggs.

"This process is repeated three or four times each Spring during the spawning period, if the weather is sufficiently favorable. Naturally, each repetition is by new animals. . . .

"Warm weather alone is not sufficient for the process, but there must be at the same time a heavy rain. If this is not the case, even if it is warm enough, no animals appear and no eggs are laid.

"As early dates for the egg-laying I can give the following dates for the last four years:

1905:	March	15:	Water	Temperature	8	degrees	Cent.
1906:	"	25:	"	"	10	"	"
1907:	"	28:	"	"	7	"	"
1908:	"	10:	"	"	9	"	"

and as late dates:

1907:	April	6:	Water	Temperature	18	degrees	Cent.
1908:	"	1:	"	"	18	"	"

"In 1905 and 1906 they laid only once and in small numbers. . . . When the *Hynobius* males in warmer localities awake from hibernation, they crawl at once to the nearest place of water and there await the females. The latter come at the same time or at most a few days later, and the animals get into a state of sexual excitement, provided the favorable weather conditions hold. The Liebesspiel then takes place in the following manner.

"The males and females assemble in groups under a stone, rock or in the shadow of grasses, and swim forwards and back, up and down,

hither and thither, and the males especially make a quivering motion with their tails. Finally after ten to twenty hours the females lay the folded spindle-shaped jelly masses. Then the males swim once more hither and thither over the strings of eggs (egg sacks), and it looks as if they squirted out semen over the jelly masses.

"In most cases only one end of this spindle-shaped string sticks fast to a stone, rock or branch dipping into the water, on the base of a tree, or on grass, while the other end is free in the water and can move up or down according to the water level. If the water almost dried up, I often saw the string hanging from a stone or a twig.

"Unfortunately, I have not yet absolutely determined whether the spermatophore of the male is taken up by the cloaca of the female or whether fertilization takes place in some other way, for the act took place at night. However, it is indisputable that the union of sperm and egg takes place in the water and outside the body of the female. . . . I believe that the sperm of *Hynobius* either remains only a short time in the female cloaca and enters the egg capsule at the moment of egg-laying, or that the sperm is emitted by the male directly over the eggs after they have been laid. The sperm must be emitted by the males shortly after the egg-laying, for two hours after the eggs were laid I could observe the attraction cone on the surface of the egg, which is the first indication of the union of sperm and egg.

"A brooding habit by the male . . . is not seen in *Hynobius*. Both males and females, shortly after the completion of the spawning, crawl back on land.

"The egg sack is a spindle-shaped outer layer about 17 cm. long, in which the eggs, each protected by its own capsules, and numbering about 50, are kept. A few hours after the egg-laying, it is slim, folded, and has an opalescent appearance. But there is no curling. Presently it begins to swell, for the egg capsule increases much in size by inhibition of water, so that after 3-5 days one can hardly see any folds. This strains the egg sack and the free end curls up. Then it has a thick, skein-like appearance. After a few more days fine particles of dust settle on the jelly mass, and it takes on a dirty light yellow color.

"If it does not rain for a long time and the water in the pond dries up, the sack lies on the bottom and the outer layer dries but the eggs in it do not die immediately, but live quite a while, (10-15 days) without taking harm, and continue developing, because there is plenty of water in the real egg capsule.

"In most cases the end of the egg sack is stuck to some object. . . .

If it is laid freely in the water, it drops to the bottom. I often noticed that a part of the eggs, in such a free laid sack, are spoiled."

The eggsack is 13-17 cm. long, 1.5-1.9 cm. thick in the middle, and contains 37-70 eggs. "The number of the eggs varies with the size of the sack. A pair of sacks is laid by each female and the number of eggs is not always the same in both."

"The single egg is covered by two coats, and the interval between them is filled by a jelly mass."

The egg is 3-3.2 mm. in diameter. The inner coat fits tight to the egg at first, but later swells to a diameter of 6 mm. The outer capsule is at first 4 mm. in diameter but swells eventually to an oval whose diameters are 10 x 13 mm.

REMARKS: Very close to *H. ikishimae*. I have seen no specimens of the Kiusiu form, but from the figures and measurements it seems to differ from the species of Iki-shima in having a longer head, lighter ground color, and flatter tail. The figure of *nebulosus* in Schlegel (1838) shows an animal much resembling *tsuensis* of Tsu-shima South, but differing in having a flatter tail with mottled sides.

This seems the proper place to mention a specimen taken by Tago (1907) at Ishizuchi yama, Umegahira, province Iyo, Shikoku. He says "this animal may belong to some different species as I noticed some differences in color, spots, and also a condition of the eggs while in its body." He did not, however, describe it, but left it under *H. nebulosus*, a course which I am compelled to imitate, although I am convinced that the Shikoku animal will be found to differ both from the Hondo and from the Kiusiu forms.

#### HYNOBIUS VANDENBURGHI Dunn.

1903. *Hynobius nebulosus* Yamada, Tokyo Zool. Mag., 15, p. 73 (habits); Tago 1904, Tokyo Zool. Mag., 16, p. 73; 1907, Tokyo Zool. Mag., 19, pp. 201, 233; Okajima 1911, Anat. Hefte 45, p. 1 (otic apparatus); 1911, Anat. Anz. 38, p. 27 (otic apparatus); Okajima and Tsusaki 1921, Zeitschr. f. Anat. u. Entw. 60 (Scleral cartilages); Tsusaki 1922, Fol. Anat. Jap. 1, p. 1 (Hyobranchial apparatus).  
1921. *Hynobius naevius* Abé (part?), Tokyo Zool. Mag., 34, p. 329.  
1923. *Hynobius vandenburghi* Dunn, Proc. California Acad. Sci., (4), XII, 2, p. 28.

TYPE: California Acad. Sci. No. 26714, adult male, collected May 1907.

TYPE LOCALITY: Nara, province Yamato, Hondo.

RANGE: Southern Hondo.

DIAGNOSIS: Vomerine series medium; tail very flat; 14-13 costal grooves; toes 5; sides of tail black; middorsal line of tail yellow; yellow with black mottling; males and females similarly marked.

DESCRIPTION: Adult male, Cal. Acad. Sci. No. 26714, Nara, Province Yamato, Hondo, collected by V. Kuhne, May, 1907; 14 costal grooves; 1 costal fold between appressed toes; head width  $6\frac{1}{2}$  in length from snout to vent; head length  $3\frac{2}{3}$  in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 3, 2, 4, 1, 5 in order of length; a tubercle under base of both inner and outer fingers and toes; tail shorter than body, trigonal at base, much flattened in last two-thirds, not keeled or finned; vent formed of three slits meeting, the posterior one quite short, the whole figure wider than long; vomerine teeth beginning behind inner edge of nares; a forward, incurving branch of 4 teeth; a branch of 17 teeth running straight back and in; series separated from its fellow anteriorly by twice width of nares, meeting its fellow behind; length of series equalling distance between outer edge of nares and peak of opposite series; color light with heavy dark mottling; upper edge of tail light; sides of tail black; belly light; total length, 99 mm., head 12.5, body 46, tail 40.5.

Variation: an adult female, Cal. Acad. Sci. No. 25949, Central Hondo, has 13 costal grooves; head width  $4\frac{1}{2}$  in length from snout to vent, head length 4 in length of body; vent a longitudinal groove, the front half of which opens to the inside; vomerine teeth as described but 5 teeth in the outer and 25 in the inner branch; total length 110 mm., head 13, body 53, tail 44.

The tail may be longer than the body; two males (Cal. Acad. Sci. No. 25948, 25950, Central Hondo) have the vomerine series as long as the distance between the outer edge of the nares and halfway between the inner edge of the opposite nares and the peak of the opposite series; No. 25950 shows the extreme breeding development of the male vent; the longitudinal groove has disappeared and the vent is formed by two grooves meeting in an angle, apex forward, a tubercle indenting the apex of the angle; the coloration of this specimen is light yellowish brown, almost obscured by heavy black mottling, light gray below, sides of tail black, upper and lower edges of tail light. In three of the five specimens I have seen two costal folds separate the



appressed toes, the exceptions being the type and No. 25949, which last is the only one to have 13 costal grooves, the rest having 14. Measurements of three males:

"Japan"						
Cal. Acad. Sci. No. 35391	total	114 mm.	head	14	body	49
" " 25948	"	120	"	14	"	52
" " 25950	"	118	"	14	"	51
					tail	51
					"	54
					"	53

**HABITS:** Yamada (1903) made some observations on this species which he says is called "Hatake dojo" by the Japanese, a name meaning "Field Loach" owing to a real or fancied resemblance to the "Dojo," or Loach, a kind of small fish. He says that the toes have "a certain clasping power at the extreme end so that they can climb up an almost perpendicular surface." They are often found "under a pile of old bricks and stones when there is sufficient dampness." Their food is "small insects or worms, especially the latter." "Disposition like a crab, as they like to be under cover of some object." "When they see a worm their eyes stand out and slowly getting near to it they suddenly seize it just as a frog does. The breeding season is May, when they go into a ditch where they find sufficient water. Their eggs are white and small, and are wrapped in chain-like groups by a gelatinous substance, the strings being about the size of a pencil. When the young are hatched they are about  $\frac{1}{4}$  inch long. It is doubtful whether they have balancers or not." "Very often while young they change their skins, which habit becomes less frequent as they grow old." "As people use this animal for medicinal purposes it is quite hard to get them."

**REMARKS:** This animal differs from its near allies sufficiently to merit recognition. From *tsuensis* of Tsu-shima South, it can be told by the much flatter tail, and by the fact that the males are not black; from *nebulosus* of Kiusiu by the flatter tail, which has black sides; from the Iki-shima and Tsu-shima North forms, by the flatter tail and by the coarser marbling. It is not close enough to any other forms to cause confusion. These five, however, have the vomerine series practically identical. The Hondo form has an extremely flat tail, while the other four differ mainly in color, and although they can easily be told apart it is difficult to formulate descriptions as there is much variation. The five form a closely allied group of which the Hondo form is the most specialized.

I refer Abé's "*H. naevius*" from Bingo to this form. It had short vomerines, lacked the tail, the appressed toes did not meet, and there

were 13 costal grooves. It was a female with head length 17 mm., and body length 36 mm.

*Pachypalaminus boulengeri* is probably closest to the present animal.

The range according to Tago (1907) is mainly south of Tokyo. Definite localities are few. Besides Nara, in Yamato Province, Tago (1907) records it from Unebi in the same Province, Okajima (1911) from Asakawamura, Musashi Province, and Abé (1921) from Bingo Province.

Specimens seen: 5, as follows;

Hondo: Province Yanato; Nara 1 (Cal. Acad. Sci. 26714).

Central Hondo 3 (Cal. Acad. Sci. 25948-50).

Japan: 1 (Cal. Acad. Sci. 35391).

#### Genus PACHYPALAMINUS Thompson.

1912. *Pachypalaminus* Thompson, Proc. California Acad. Sci. (4), 3, p. 183, (type *Pachypalaminus boulengeri* Thompson).

RANGE: Same as that of type species.

DIAGNOSIS: *Hynobiidae* with horny covering to palms and soles and over tips of digits; premaxillary fontanelle large; lungs ?; gills of larvae ?; vomerine teeth in V-shaped series; tail very flat; one species.

#### PACHYPALAMINUS BOULENGERI Thompson.

1912. *Pachypalaminus boulengeri* Thompson, Proc. California Acad. Sci. (4), 3, p. 184, pl. 14.

TYPE: Cal. Acad. Sci. no. 33192, adult male.

TYPE LOCALITY: Odaigahara Mt., Yamato, Hondo, Japan.

RANGE: Known only from type locality.

DIAGNOSIS: A salamander with the dentition of *Hynobius*; a very flat tail; "palms, soles, and inferior surface and tips of fingers and toes covered with a tough brown corneous modification of the epidermis," (as in *Batrachuperus*); no markings.

DESCRIPTION: "Head large, depressed, and as broad as long; snout long and rounded; nostril situated a trifle nearer to the orbit than to the tip of the snout; eyes rather large and prominent; orbit contained one and one third times in the length of the snout. Series of palatine teeth interrupted, not forming a reentrant angle; apices of the two

salient angles on a line with the centers of the choanae; the length of the inner side of one of the angles equal to the interval between the choanae; the length of the outer side equal to one third this interval. Tongue circular, strong and fleshy, filling the floor of the mouth, the surface finely and longitudinally plicate; two fairly deep sulci with a general antero-posterior trend, their outline that of two laterally directed obtuse angles, enclosing about one half the central area of the tongue. The gular fold moderately developed. Body depressed; distance from the snout to the gular fold contained nearly three times in the distance from the latter to the cloaca; median dorsal groove, markedly deepened over the pectoral and pelvic regions; thirteen well developed costal folds, including the one flexed to enter the axilla and the one reaching the groin; the nine middle folds continued across the abdomen. Vent (of male) three slits meeting in front, the medium longitudinal and longest, the two others obliquely directed forwards, forming an angle; the borders swollen. Limbs stout, when appressed the digits overlap for about two millimeters. Digits well developed. Tail a trifle longer than the distance from the gular fold to the cloaca, strongly compressed, deepened and fleshy in the posterior half; not keeled; the tip rounded. Skin smooth; numerous mucous glands on snout, around nostrils and eyes, and on upper and lower lips; paratoids distinct; an irregular horizontal groove from eye to gular fold, joined by a short vertical one posterior to angle of mouth. Color in spirits slate, a trifle paler beneath." Total length 161 mm., head 23 mm., body 69 mm., tail 69 mm.

REMARKS: Thompson says "the larvae possess stout claws." This is not quite clear, because the type is the only specimen known. Larvae of *Batrachuperus* possess the peculiar foot coverings of the adults, and as the same modification exists in *Pachypalaminus*, one might expect its larvae likewise to resemble the adults in this respect.

The relationships are clearly with *Hynobius*. Among the species of that genus it most resembles *H. vandenburghi* of the same region in Hondo. It may well be a very local aquatic modification of that form.

It certainly has nothing to do with *Batrachuperus*, in spite of the similar modifications of the feet, which may be considered as parallelism which have appeared independently in animals of common ancestry.

Dr. Van Denburgh has kindly examined the skull of *Pachypalaminus* for me and sent me a sketch of it. I find that it differs from that of *Hynobius* in having a large premaxillary fontanelle.

Genus *ONYCHODACTYLUS* Tschudi.

1838. *Onychodactylus* Tschudi, Mem. Soc. Sci. Neuchâtel, pp. 57, 92 (type *Onychodactylus schlegeli* Tschudi).  
 1839. *Dactylonyx* Bibron, in Bonaparte, Icon. Fauna Ital., 2, fasc. 26, (substitute for *Onychodactylus* Tschudi).  
 1854. *Onychopus* Dumeril and Bibron, Erpet. Gen., 9, p. 113 (substitute for *Onychodactylus* Tschudi).  
 1886. *Geomolge* Boulenger, Proc. Zool. Soc. London, p. 416 (type *Geomolge fischeri* Boulenger).

RANGE: From Khabarovka, Maritime Gov., to Wonsan, Korea. Hondo and Shikoku.

DIAGNOSIS: *Hynobiidae* with claws in larvae and in some adults; no lungs; premaxillary fontanelle large; gills of larvae without filament bearers; vomerine teeth in a nearly transverse and continuous series; tail long and nearly cylindrical; two species.

*ONYCHODACTYLUS JAPONICUS* (Houttuyn).

1782. *Salamandra japonica* Houttuyn, Verh. Genootsch. Wetensch. Vlissingen, 9, p. 329, pl. facing p. 336, f. 3.  
 1787. *Lacerta japonica* Thunberg, Svensk. Vet. Akad. Nya Handl., 8, pl. 124, pl. 4, f. 1 ("Fakoneberget").  
 1839. *Onychodactylus japonicus* Bonaparte, Icon. Fauna Ital., 2, fasc. 26; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 33, pl. 3, f. 15; Troschel 1877, Arch. Naturg., 1, p. 199, pl. 15 (elaborate descriptions of adult and larva); Hilgendorf 1880, Sitz. Ber. Naturf. Berlin, p. 121; Boulenger, 1882, Cat. Batr. Grad. Brit. Mus., (2), p. 35; Cope 1889, Bull. U. S. Nat. Mus. 34, pl. 46, f. 6 (carpus and tarsus); Okada 1891, Cat. Vert. Japan, p. 65; Tago 1903, Tokyo Zool. Mag., 15, p. 464; 1904, Tokyo Zool. Mag. 16, p. 43; Stejneger, 1907, Bull. U. S. Nat. Mus. 53, p. 42, pl. 5, f. 1-4, pl. 6; Tago, 1907, Tokyo Zool. Mag., 19, p. 238 (habits); Okajima, 1908, Zeitschr. Wiss. Zool. 91, p. 351 (osteology); 1909, Zeitschr. Wiss. Zool. 94, p. 171 (sense organs); 1909, Anat. Anz., 34, p. 182 (hyobranchial apparatus); Dunn, 1918, Bull. Mus. Comp. Zool., 52, p. 454; Okajima and Tsusaki 1921, Zeit. Anat. Entw. 60 (scleral cartilages); Okajima 1922, Fol. Anat. Japon., 1, p. 196 (hyobranchial apparatus).  
 1798. *Lacerta thunbergii* Donndorf, Zool. Beytr., 3, p. 132 (based on Thunberg 1787).

1820. *Molge striata* Merrem, Tent. Syst. Amph., p. 185 (based on Houttuyn and Thunberg).
1838. *Salamandra unguiculata* Schlegel, Fauna Japon., Rept., p. 123, 129, pl. 5, ff. 1-6 (Hondo and Shikoku); Geerts, 1883, Nouv. Arch. Mus. Paris, (2), 5, p. 275; Goppert, 1896, Morph. Jahrb. 25, p. 16, ff. 15-16 (claws).
1838. *Onychodactylus schlegeli* Tschudi, Mem. Soc. Sci. Neuchâtel, p. 92 based on Schlegel 1838); Duméril and Bibron 1854, Erpet. Gén., 9, p. 114, Atlas, pl. 93, f. 1.
1841. *Onycopus sieboldii* Duméril and Bibron, Erpet. Gén., 8, p. 4 (lapsus).
1879. *Onychodactylus* sp. Parker, Trans. Linn. Soc. London, (2), 2, part 3, No. 5, p. 188, pl. 19, ff. 1-3 (skull and hyobranchial apparatus).

TYPE: Not known to exist. Collected by Thunberg.

TYPE LOCALITY: Not definitely stated but evidently the "Fakoneberget" (mountains of Hakone, Izu Prov.), where Thunberg collected the types of his *Lacerta japonica*.

RANGE: Mountains of Hondo and of Shikoku.

DIAGNOSIS: An *Onychodactylus* with 13-14 costal grooves, generally no gap between vomerine series, a very marked light dorsal band.

DESCRIPTION: Cal. Acad. Sci. No. 26711, adult male, Sawatari, Prov. Kotsuke, Hondo, Sept., 1910; 14 costal grooves; appressed toes meeting; head width 6 in length from snout to vent; head length  $3\frac{2}{3}$  in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold, a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 5, 2, 1 in order of length; a tubercle under base of first finger and toe; a fold of skin along outer edge of fifth toe and lower leg; tail longer than head and body, cylindrical at base, flattened towards tip; vent a longitudinal slit with a pair of shorter slits meeting it so as to form an arrowhead appearance, point forwards; Vomerine teeth, 15 in series, beginning behind inner edge of nares, curving forward and in to level of anterior edge of nares, thence back and in to meet its fellow, not so far back in middle as on sides; yellowish brown, a dorsolateral black stripe on body and tail, much black spotting on dorsal surface; sides below the stripe cream color clouded with darker, nearly uniform cream color below; total length 151 mm., head 15, body 56, tail 80.

Variation: An adult female, Cal. Acad. Sci. No. 16021, Yokohama, Hondo, collected by J. C. Thompson; 13 costal grooves; stout claws on fingers and toes; tail longer than body; vent a longitudinal slit;

black above, lighter below a light dorsal streak from head to tip of tail, total length 136 mm., head 15, body 58, tail 63.

The larvae have dorsal fin only on tail; there is a fold of skin along the outer edge of arms and legs. There is great variation in color, some larvae having a marked dorsal light stripe, while others do not. All have black claws.

Schlegel (1838) says that the larvae and the breeding males and females have claws. Troschel, in 1877, claimed that the claws are confined to larvae and males, as his series of females had no claws. Stejneger (1907) shows that breeding females are provided with claws, and suggests that males have claws the year round and females have them only in the breeding season. Three clawless males, Cal. Acad. Sci. No. 26709-11, from Sawatari, Kotsuke Prov., Hondo, taken in September seem to indicate that Schlegel was right and that claws are seasonal and possessed at times by both sexes.

The vomerine teeth do not always meet in the median line, being sometimes separated by the width of the nares.

The fibulo-tarsal dilation of the male is supposed to be present only in the breeding season, but was very noticeable in the clawless, September males mentioned above.

The anus of the breeding female is very similar to that of the male, but never so developed, and the posterior pair of lateral slits join the longitudinal one in the middle of its length, instead of near its front end.

Tago's smallest larvae were 25-30 mm. long. His smallest transformed specimens were 60-65 mm. long. He says they grow to 180 mm. Troschel (1877) records larvae 87 mm. long. The males are in general the larger.

HABITS: Schlegel (1838) says; "The Japanese call this salamander *San-sjo-uwo*, but in the mountains where it lives, they call it by the Chinese name of *Kao chou youen he yu*, which means black fish of the mountain springs.

"It is found particularly in mountainous country.

"Those which come from Mount Facone are very celebrated, and are sold in Pharmacies as *Fakone-no-san-sjo-uwo*. They attribute to them medicinal qualities analogous to those of the giant salamander, and their use is particularly recommended as a vermifuge for children.

"This species frequents the sources of brooks and damp places in the mountains. It usually stays in the cracks of cliffs near these places and only comes out in the evening to seek its food, which is small mollusks, terrestrial and aquatic insects and worms. So, during

the night, the Japanese, with torches, go to hunt these animals, which they catch in abundance on damp, moss-covered rocks.

"It is said that they stay by preference near waterfalls, and that they like to climb on the damp walls of the cliffs whence they precipitate themselves into the water. They catch them then with lines and put them alive into terra-cotta pots. In preparing them for medical use they pierce the head without gutting them and thread them on a thin bamboo so as to form packets of 10-20. When dried they are brown and oily to the touch.

"The larvae appear at the end of April. Mr. Siebold has seen them at this time during his stay in the Fakone Mts."

Tago (1907) describes the habits as follows: "This animal always likes a cool, shady place where they do not have the direct light of the sun, and with considerable dampness and clear water."

He describes the junction of a small river with the Sukumo River at Kiwadasawa, Sagami Province. "At this junction in the woods hundreds of these animals gather every year.

"Nearly a mile up this stream beyond a rapid there is a large rock on the left covered with wild wistaria and other vines and called *Kuro yuwa* or *Tate yuwa* (Black Rock or Standing Rock) and many years ago, so I understand, the water was so high that it covered half of this rock and made a fall to the valley behind it.

"Every spring when the azaleas begin to bloom hundreds of these animals, male as well as female, gather on this rock and the inhabitants catch them by the light of torches.

"In Nikko they call this animal *Hibihari* and young ones are found in the ponds of Nikko shrine, Umagayeshi, around Chugushi Lake, Yuhake, and other waters in the mountains, but adults seem to be restricted to two or three places, and it is difficult to catch them unless you know a definite place where they live. The most convenient places to find them are in woods near lakes, where it is shady and damp and usually with northern exposure. Every year I used to catch them at Suganuma, Katashinamura Tome, Gumma Prefecture.

"The lake is about ten miles in circumference, running north and south, irregular in width, its three wide spaces being called Irinuma, Nahanuma, and Kitamata. Covered with thick spruce of natural growth, and with the mosses and detritus of several centuries it is naturally kept shady and damp and suited to the happiness and comfort of this animal, and we can find them always under these shady places, but in the breeding season they come out to the beach at a point where it is open to the north.



"In the lake we find both this animal and *Hynobius fuscus* which generally keep apart, the former in shady damp places, with northern exposure, while the latter keep themselves more or less in the sun with eastern or western exposure, and both under cover of rocks and decayed roots, although the former does not burrow as much as the latter, and seems to go into the water at night as they are found in some of the lake fishes — in fact, some had more than two in their stomachs."

The young "generally live in clear water less than six inches deep, in a small stream or around the lake where there are plenty of bushes on the bank and lots of pebbles on the bottom of the water, or sometimes in cold water less than 10 degrees Cent. in hot summer which is found on a north mountain slope.

"The best way to catch them in these circumstances is to dry out the water first and to move pebbles and rocks at the bottom although very often we use a net.

"As soon as it loses gills and starts to live on land they go into the bushes or woods and hunt for a place most suited for their comfort and happiness.

"Even in those places described above they live in most cases singly among mosses, decayed trees, under rocks and even in a decayed hole in a tree near the water, where they hide themselves most of the day and go out at night after food, which mostly consists of live fish, tadpoles, worms, insects, and their eggs as well as young ones.

"Although they dislike a great deal of sun and dry places they wander far from their lairs at night or during a rain, and often go into the water, or go up to a mountain summit by a stream, and occasionally are caught in a path.

"Their winter is spent in the ground, under the root of a tree, or rocks or in the hollow of a dead tree, and sometimes they come out in groups.

"In the spring early in May when the wild azaleas starts to bloom at Hakone they come out of their long winter retirement and start for the distant breeding place along water-ways. On a warm, rainy night with south wind they come out to the lover's lane to find a mate and from every corner of stream, spring, or pond they gather to a comparatively large river or lake such as that at Kiwadasawa above the Sukumo river at Kuroyuwa (Black Rock) or Suganuma described above and also in Iwaki, my native place, at a junction of two rivers.

"There is no way to describe accurately their breeding as this is done in the darkness of night.

"A female taken at this season had 30-40 eggs; whether these eggs

are thrown out as they are, or as larvae after being kept some time in the oviduct, I regret very much that I have not had an opportunity to decide.

"It is very doubtful as to their medical worth, although they have been sold for years under this impression as *Magotatomushi* and at Hakone, Amaki, and Kuroyama, district of Nikko, they catch them by means of weighted baskets in the breeding season when they migrate along the valley, and preserve them by broiling after killing them in salt water."

REMARKS: This animal is extremely close to the Korean species. Far from being generically distinct it is doubtful if any constant character separates the two species. The Korean form generally has a gap between the vomerine series, one more costal groove, and the light dorsal band is not very distinct. This color character is the best means of distinguishing between the two. So far, none of the mainland adults have been found with claws. But few mainland adults have been found. The larvae of the two forms cannot be separated, save those Japanese specimens which have less than 14 costal grooves and those mainland ones which have more.

There is considerable similarity between Schlegel's and Tago's account of the habits and one wonders whether Schlegel also did not have reference to Kuroyuwa near Hakone.

Schlegel's account might be bodily transferred to some of the American mountain brook species.

It is noteworthy that this animal and *fischeri* apparently have developed the legs rather than the tail for swimming. For the disproportionate development of the outer toes is always found in aquatic animals which use the legs for propulsion. This development is unique among salamanders, so that for comparison one must refer to Plesiosaurs.

Besides the localities mentioned in the list of specimens it has been recorded from the following places:

Hondo: Mottsu Province, Kitagami Mts. (Tago 1907).

Rikuoku " " " " "

Rikuzen " " " " "

Iwaki " (Okada 1891); Abukuma Mts. to Takahara (Tago 1907).

Hitachi Province, northern boundary of Tsukuba Mts. (Tago 1907).

Sagami Province, Hatta, Oyama, (Hilgendorf 1880), Kiwadasawa, Hatashiku (Tago 1907).

Idzu	Province, Amaki Mts. (Tago 1907).
Shimozuke	" Nikko (Tago 1907).
Kotsuke	" Saganuma (Tago 1907).
Shinano	" (Schlegel 1838).
Iga	" (Geerts 1883).
Ise	" (Tago 1907).
Tamba	" (Schlegel 1838).
Tozima	" (Schlegel 1838).

Border between Mimasake and Hoki (?), (Tago 1907).

Shikoku: Tosa Province (Schlegel 1838), Yamaba (Tago 1907).

Tago (1907) says of its altitudinal range "Thus in warm regions they live high up in mountains or valleys of 500-1000 ft., while in northern states we find them very often on a hill or in a stream only 300-500 ft. above the sea."

Specimens seen: 98, as follows;

Mimaya, Rikuoku Province, 1 larva (Cal. Acad. Sci. 26715).

Sawatari, Kotsuke Province, 5 (2 larvae), (Cal. Acad. Sci. 26709-13).

Tokyo (?), 1 larva (M. C. Z. 1864) (larva).

Yokohama (?), 1 larva (Cal. Acad. Sci. 16021).

Hakone Lake, Sagami Province, 87 (45 larvae): (M. C. Z. 2594, 9 larvae), (M. C. Z. 2595, 6 larvae), (M. C. Z. 2586, 4 adults), (U. S. N. M. 34218-46, 34249-57, 34258-87 larvae).

The localities Tokyo and Yokohama should be taken with a grain of salt, more especially as the animals are articles of commerce.

#### MEASUREMENTS OF *Onychodactylus japonicus*.

\* = costal grooves.

/ = costal folds between appressed toes.

Specimen	Sex	Total length	Head	Body	Tail	*	
U. S. N. M. 34220	female	159	15	62	82	14/0	clawed
" 34221	male	168	16	63	89	14/0	"
" 34227	female	128	15	58	55	13/0	"
" 34256	male	142	14	55	73	13/0	"
(These are the largest and smallest adults seen.)							
Cal. Acad. Sci. 16021	female	136	15	58	63	13/0	clawed
" 26709	male	140	15	55	70	13/0	no claws
" 26710	"	144	15	55	74	13/0	"
" 26711	"	151	15	55	80	14/0	"
" 26712	larva	78	10	33	35		clawed
" 26713	"	61	8	26	27		"
" 26715	"	69	8	31	30		"
" 16017	"	70	9.5	30.5	30		"
" 16018	"	73	9.5	28.5	34		"

## NYCHODACTYLUS FISCHERI (Boulenger).

1886. *Geomolge fischeri* Boulenger, Proc. Zool. Soc. London, p. 416, pl. 39, f. 2; Nikolski 1896, Ann. Mus. Zool. St. Pétersbourg, 1, p. 77; 1905, Zap. Imp. Akad. Nauk, S. Peterburg (8), 17, p. 440; 1918, Faune de la Russe, p. 242, f. 45; Abé 1921, Tokyo Zool. Mag., 34, p. 328.
1918. *Onychodactylus fischeri* Dunn, Bull. Mus. Comp. Zool., 42, p. 454.
1913. *Onychodactylus rossicus* Nikolski, Ann. Mus. Zool. St. Pétersbourg, 18 (2), p. 260 (type locality, Ussuri); 1918, Faune de la Russe, p. 259, f. 57-58, pl. 4, f. 5.

TYPE: Brit. Mus. No. 86.5.15.11-12, collected by Doerries.

TYPE LOCALITY: Khabarovka.

RANGE: From Khabarovka to Wonsan in Korea.

DIAGNOSIS: An *Onychodactylus* with 14-15 costal grooves, generally a slight gap between vomerine series, light dorsal band rather obscure.

DESCRIPTION: Cal. Acad. Sci. No. 32170, adult male, Wonsan, Korea, collected by Victor Kuhne, June 7, 1911; 14 costal grooves; appressed toes meeting; head width 7 in length from snout to vent; head length 4 in length of body; head oval from above; eye longer than distance from tip of snout; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; upper and lower eyelid fitting under a fold of skin behind; a groove from hind angle of eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 2 and 3 equal in length, 1 and 4 equal and shorter than 2 and 3; toes 4, 3, 5, 2, 1 in order of length, a fold of skin along hind edge of fibula and fifth toe; tail longer than body; cylindrical throughout most of its length, flattened at tip; vent a longitudinal slit joined at tip by two shorter oblique slits directed forward, and joined one fourth its length back from the tip by two other similar slits, opening of vent between tip and posterior short slits; vomerine teeth in two series of about 19 teeth each; series beginning behind middle of nares, curving forward and in to level of anterior edge of nares, thence back and in, but not so far back in middle as on sides, separated from its fellow by one-half width of naris; cream color above and below, very heavily mottled above with black, on the tail this mottling takes the form of two dorsolateral stripes; total length 160.5 mm., head 17.5, body 68, tail 75.

Variation: No adult females have been seen. Three other males, same data, all have 14 costal grooves. Boulenger (1886) says "14 or 15." In these three the third finger is longer than the second as in *O.*

*japonicus*. In the smallest, No. 32171, the vent is a simple longitudinal slit. In No. 32172 the tail is longer than the head and body. The vomerine teeth may be as few as 14 in a series, this being the number in No. 32172.

The larvae are similar to those of *O. japonicus*, even to the extent of having two color phases, with and without a marked dorsal light stripe. All have strong black claws and black horny beaks on the lower jaw. I give the measurements of the four adults and of the largest and smallest larvae.

32169	adult ♂	140.5	15.5	58	67	
32170	" ♂	160.5	17.5	68	75	
32171	" ♂	116	13.5	47.5	55	
32172	" ♂	168	17.5	60.5	90	
32219	larva	97	9	45	43	marbled heavily
32262	"	97	11	39	47	
32199	"	95	11	40	44	an immaculate dorsal area
32993	"	27	4	13	10	
32992	"	33	4	14	15	

Abé (1921) records a female from Hokkanzan, Korea, having claws on fingers, total length 148 mm., head 14, body 51, tail 33.

The female type in the British Museum has head 14 mm. long and body 66.

The male type has total length 163, head 12, body 58, tail 93.

Apparently these Ussuri specimens have shorter heads than the ones I have seen from Korea.

REMARKS: As has been said under *O. japonicus* the two species of this genus are extremely closely related. They are closer in fact than are the *Hynobius* of the Islands in the Korean straits (*tsuensis*, *tagoi*, and *ikishimae*).

Nikolski's *Onychodactylus rossicus* was based on a claw-bearing larva 75 mm. long.

Besides the following specimens from Wonsan, Boulenger has recorded two from Khabarovka (1886), Nikolski (1896) one from the valley of the Sutchan, and (1913) one from the Ussuri, and Abé (1921) has recorded it from Hokkanzan, Korea.

Specimens seen: 228, as follows;

Korea: Wonsan, 4 adults (Cal. Acad. Sci. 32169-32172).

224 larvae (Cal. Acad. Sci. 32173, 32175-202, 32204-32209, 32211-32373, 32984-32993, 35977-35988, Amer. Mus. Nat. Hist. 14503-14506).

## Genus RANODON Kessler.

1866. *Ranodon* Kessler, Bull. Nat. Moscou, 39, p. 126 (type *Ranodon sibiricus* Kessler).  
 1882. *Ranidens* Boulenger, Cat. Bat. Grad. Brit. Mus. (2), p. 36 (substitute for *Ranodon* Kessler).

RANGE: Same as that of type species.

DIAGNOSIS: *Hynobiidae* with no foot modification; lungs present; premaxillary fontanelle small; gills of larvae?; vomerine teeth in two short, widely separated series; tail flat; one species.

## RANODON SIBIRICUS Kessler.

1866. *Ranodon sibiricus* Kessler, Bull. Nat. Moscou, 39, p. 126, pl. 7, f. 1-10; Strauch 1870, Mem. Acad. Sci. St. Pétersbourg (7), 16, p. 66, pl. 11, f. 3; Severtzof 1873, Izv. Imp. Obst. Lyub. Est., 8, 2, p. 72; Wiedersheim 1876, Morph. Jahrb. 2, p. 424, pl. 29, f. 2-3 (extremities); 1877, Morph. Jahrb. 3, p. 422, pl. 23, f. 68-70 (skull); Kehrer 1886, Ber. Nat. Ges. Freiburg, I, p. 4, pl. 4, f. 3, 4, 15 (extremities); Nikolski, 1887, Tr. Spb. Obstch. Est. 19, p. 162; Schmalhausen 1917, Rev. Zool. Russe 2, p. 129 (extremities); Stejneger 1917, Proc. Biol. Soc. Washington, 30, p. 123; Nikolski, 1918, Faune de la Russe, p. 247, ff. 48, 49-55.  
 1882. *Ranidens sibiricus* Boulenger, Cat. Bat. Grad. Brit. Mus. (2), p. 36; Kulagin 1888, Izv. M. Obstch. Lyub. Est. 56, 2, p. 34; Boettger 1888, Ber. Offenbach Ver., p. 169; Nikolski 1899, in Fedtschenko "Reise in Turkestan," Zool. 2, pt. 7, p. 78; Kastschenko 1902, Izv. Tomsk Univ., p. 20; Nikolski 1905, Zap. Imp. Akad. Nauk. S. Peterburg (8), 17, p. 441; Elpateevski and Sabaneev 1907, Zool. Jahrb. Syst. Th. 24, p. 263; Snitnikov 1913, Ann. Mus. Zool. St. Pétersbourg 18, p. 53 (habits).  
 1868. *Ranodon Kessleri* Ballion, Bull. Nat. Moscou 41, p. 138 (Kopal); Severtzof, 1873, loc. cit., p. 72.  
 1873. *Ranodon* sp. Severtzof, loc. cit., p. 72.  
 1918. *Ranodon kozhevnikovi* Nikolski, Faune de la Russe, p. 251, ff. 49-55, pl. 3, f. 5 (Tashkent).

TYPE: None known to exist.

TYPE LOCALITY: "Neighborhood of Semipalatinsk," possibly erroneous.

RANGE: Known certainly from Eastern Semirychensk and Western Chinese Turkestan, and it possibly occurs in Semipalatinsk and in Syrdarya.

DIAGNOSIS: A salamander with toes 4-5; vomerine teeth in two short widely separated series between the nares; flat tail; no labial folds; no horny covering to palms and soles.

DESCRIPTION: U. S. Nat. Mus. No. 14365, adult male, Kopal, Semirychensk Gov.; 12 costal grooves; appressed toes meeting; head width  $4\frac{1}{2}$  in length from snout to vent; head length 3 in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw straight as seen from side; lower eyelid fitting under upper in front and behind; angle of jaw back of hind angle of eye; a groove from eye to gular fold; a groove from this down behind angle of jaw; a fold of skin on sides between insertions of limbs; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; fingers and toes flattened towards tip; tail longer than body, flattened considerably; vent a longitudinal slit; vomerine teeth beginning behind inner edge of nares, a series of 6 teeth curving forward and in to level of middle of nares, series separated from its fellow by width of nares; color (faded) light brownish gray, with a few black dots on dorsal surface; total length 104 mm., head 14, body 41, tail 49.

Variation: A nearly transformed larva, Mus. Comp. Zool. No 1964, same locality; 13 costal grooves, one costal fold between appressed toes; labial folds on upper and lower jaw; otherwise like adult; total length 97 mm., head 11, body 40, tail 46.

According to Strauch (1870) the vomerine teeth converge forward in the young, but are quite transverse in the adult.

He gives measurements of a series from Kopal and from Kuldja in Chinese Turkestan, which I here reproduce.

Locality	Total length	Head	Body	Tail	Remarks
Kopal	219	23	78	118	
"	208	23	74	111	
Kuldja	192	20	66	106	
Kopal	182	20	65	97	
"	151	19	54	78	
"	111	14	42	55	
"	97	12	39	46	
"	97	13	38	46	
"	100	12	40	48	Has rudiments of gills

Apparently the relative length of the tail increases with age.

HABITS: Snitnikov (1913) has a paper on the habitat and habits of *Ranodon* from which I quote the following.



"This salamander is characteristic of a purely mountain fauna; an inhabitant of mountain brooks at a considerable altitude."

He was able to find none at 1500 meters or at 1850 meters. Finally at greater altitudes in small streams in the Urgan-Tas Mts. between Kopal and Djarkent, he found them in abundance.

"In a large stream which flows in this region I took a series of adults, and some of the egg-sacks. In the next days of my sojourn I tried to hunt in other similar streams and I found salamanders in all of them but no egg-sacks. All these streams are at about 1900-2000 meters of altitude and flow into a little river, the Kesken-Terek, at about 1800 meters. The streams rise from springs on the mountain-side. In these streams, which I would not really call streams, but tiny brooks, some only  $\frac{1}{4}$  arshin (7 inches) wide, the animals can be found, but in those lower than 1850 meters I found none."

"The sources of these brooks are rocky and the salamanders are under the rocks in the daytime." "I only found two at the water level on wet and moss-covered rocks, whose tops were out of water. All the others were under stones in the water. Here they spend the whole day. I never saw one come out from under the stone by his own volition or swim freely in the water, or stay on the open bottom of the stream in the daytime. Only towards beginning of evening they come out from under the stones and even out of water, and you can find them along the banks, and sometimes pretty far away among Juniper bushes or in the grass."

"Dissection of some of the specimens shows that the food is largely made up of small crawfish, caddis-fly larvae and their tubes, beetles, plants, much sand which probably came from the tubes, and even pebbles as large as 6 mm. in diameter. As this food was not digested and recently eaten the salamanders eat even in the daytime.

"They lay eggs at the end of June, because I found in the first days of July, 1908, eggs in cleavage stages, probably 5-6 days old, larvae just hatched, mature eggs in which the process of hatching was observed, and eggs not yet developed and freshly laid.

"The young just before it emerges, wriggles back and forth and breaks through the thin cover of the egg, goes through the opening, and swims immediately to the bottom, swimming like a snake, with legs flat against the body.

"The egg-sacks are fastened to the under sides of flat stones in the water. The water flows under such stones, so that the egg-sacks, which are slim and spindle-shaped, and fastened by one end, are continually swept back and forth by the water.

"The eggs are protected from shock by stiff jelly. When larvae emerge the egg opens in the same direction as the opening of the bag.

"The jelly bag remains attached to the rock empty and flat after all the animals have gone.

"The bags vary a great deal in size and in number of eggs contained. Some are 2-3 vershok (4-6 inches) long, and some are even  $\frac{1}{2}$  arshin (14 inches) long, and the number of eggs varies accordingly. I have a bag shrunk in alcohol which measures  $2\frac{1}{2}$  duima ( $2\frac{1}{2}$  inches), and contains 25 eggs.

"The egg at hatching measures 1 cm. in diameter, and the larva is 1.75 cm. long. They have well developed front legs and perceptible hind legs. The dorsal fin reaches the head. In the next stage, 2.5 cm., the dorsal fin reaches the middle of the body, and the larva has developed hind feet.

"The young are lighter in color than the adults. The background is yellow with many brown dots which later become the background.

"Many specimens have well developed gills, but otherwise do not differ from those without gills. No very large ones were found with gills, so probably those with gills are young ready to transform.

"203 and 210 mm. were the lengths of my largest adults, the medium sized examples were 150 mm. long, and the smallest were 90 and 85 mm.

"The only specimen with atrophied gills is the smallest of all and is 81 mm. long, while two with gills measure 92 and 95 mm.

"They normally live under stones, and their motion is halfway between a swim and a crawl. But in deep water they put their legs to their sides and swim with their tails. They probably feel uncomfortable for they immediately try to find a stone and go under it.

"Both Kirghiz and Cossacks believe that these animals when dried in the sun and powdered are a good medicine for broken bones. Dried salamanders can be found in every Kirghiz or Cossack village. In places they have been exterminated by catching them for this purpose."

REMARKS: *Ranodon* is an isolated species whose relationships are remotely with *Hynobius*, perhaps with its recently described compatriot *H. turkestanicus*. It certainly has nothing to do with *Batrachuperus*. The two are independent more aquatic derivatives of *Hynobius*, and the similar dentition, due to weakening of the prevomers, is probably a parallelism.

*Ranodon kessleri* does not seem to be a distinct form.

Strauch (1870) stated that this animal occurred in Northeast China, but as his only Chinese locality was Kuldja, which is in the extreme

western part of Chinese Turkestan, "Northeast" must have been a slip for Northwest. This error has been copied many times.

Nikolski (1905) questions Kulagin's (1888) record for Tashkent. To this Elpatevski and Sabaneev (1907) reply that a specimen with this locality, and said to have been collected by Fedtschenko, is in the Moscow Museum. Nikolski (1918) bases his *Ranodon kozhnikovi* on this specimen. The characters are minute differences in proportion from *R. sibiricus*. If *Ranodon* varies as much as *Hynobius* does the form is certainly not valid.

Kastschenko (1898, Nauk. Tomsk.) has recorded this form from north of the Altai in the Tomsk Government, but later (1902) stated that he was mistaken and really had *Molge vulgaris*. In the latter paper he says he heard from Cossacks about some salamanders near the village of Ulyabinsk, and believes these to have been *Ranodon*.

Snitnikov (1913), having found the animal living in mountain streams between 1850 and 2000 meters of altitude, doubts whether the type actually came from "the neighborhood of Semipalatinsk" because there is no country of anywhere near such elevation in that vicinity. He suggests that the type really came from Semirychensk, which was not a separate Government when Kessler wrote, but was a part of the Semipalatinsk Government. He says also that both "Kuldja" and "Kopal" refer not to the towns but to the quite large districts of which they are the centers.

Besides Kopal, whence came the specimens I have seen, it has been recorded from the following places:

Semipalatinsk Gov.: Semipalatinsk (Kessler 1866).

Semirychensk Gov.: River Maloi Almatinki near Vernaye, 6000 feet alt. (Severtzov 1873); river Balykty near Kopal (Nikolski 1905); river Chimbulaki near Kopal, river Kora near Kopal, headwaters of river Kesken-Terek in Urgan-Tas Mts. at alt. of 1850-2000 m. between Kopal and Djarkent (Snitnikov 1913).

Syrdarya Gov.: Tashkent (Kulagin 1888).

Chinese Turkestan: Kuldja (Strauch 1870).

Specimens seen: Two, as follows;

Semirychensk Gov.: Kopal (U. S. N. M. 14365, M. C. Z. 1964).

#### Genus BATRACHUPERUS Boulenger.

1878. *Batrachuperus* Boulenger, Bull. Soc. Zool. France, p. 71 (type *Salamandrella sinensis* Sauvage).

1882. *Batrachyperus* Boulenger, Cat. Batr. Grad. Brit. Mus., (2), p. 37 (substitute for *Batrachuperus* Boulenger).

RANGE: Same as that of the type species.

DIAGNOSIS: *Hynobiidae* with horny covering to palms and soles and over tips of digits; lungs present; premaxillary fontanelle small; gills of larvae without filament bearers; vomerine teeth in two short, widely separated series; tail flat; one species.

BATRACHUPERUS SINENSIS (Sauvage).

1876. *Desmodactylus Pinchoni* David, Journ. Roy. Asiat. Soc., N. China Branch, 7, p. 226 (Moupin), (nomen nudum).  
 1877. *Salamandrella sinensis* Sauvage, Bull. Soc. Philom., (7), 1, p. 115.  
 1878. *Batrachuperus sinensis* Boulenger, Bull. Soc. Zool. France, p. 71.  
 1882. *Batrachyperus sinensis* Boulenger, Cat. Bat. Grad. Brit. Mus., (2), p. 37, pl. 3, f. 1; Guenther, 1896, Ann. Mus. Zool. St. Pétersbourg, 1, p. 209; Barbour 1912, Mem. Mus. Comp. Zool., 40, p. 126, pl. 1, f. 1.  
 1898. *Salamandrella keyserlingii* Bedriaga, (part), Wiss. Result. Przewalski Zentralasiat., Zool. 3, pt. 1, p. 3.

TYPE: In Paris Museum. A cotype is U. S. Nat. Mus. No. 10995, adult female.

TYPE LOCALITY: Moupin, Sze-chuan, China.

RANGE: Known only from Sze-chuan and from the Thibetan province of Kham.

DIAGNOSIS: A salamander with toes 4-4; vomerine teeth in two short widely separated series between nares; flat tail; labial folds much developed; horny covering to palms and soles and over tips of digits.

DESCRIPTION: U. S. Nat. Mus. No. 64420, adult female, Mt. Omei, Sze-chuan, China; 13 costal grooves; one costal fold between appressed toes; head width  $4\frac{2}{3}$  in length from snout to vent; head length  $2\frac{3}{4}$  in length of body; head oval from above; eye as long as its distance from tip of snout; outline of upper jaw very convex as seen from side, owing to prominent labial fold (present also on lower jaw as in larvae); angle of jaw under hind angle of eye; both eyelids fitting under a fold of skin behind; a deep crescentic groove back of eye; a groove from eye to gular fold; a groove from lower lid to angle of jaw; gular fold extends on sides of neck to dorsal surface; limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 3, 2, 4, 1 in order of

length; palms and soles and under surfaces and tips of fingers and toes covered with thickened horny epidermis; tail longer than body, cylindrical at base, flattened gradually to tip, last half very flat; vent more or less cross-shaped, anterior edges swollen; vomerine teeth 5 in series, beginning well in and back from the very small nares, series extending inwards in slight curve, separated from its fellow by its own length; olive, indistinctly marbled with black, lighter below, anterior lips of vent white.

Variation: A male M. C. Z. No. 2848, Liang-ho-ko, western Sze-Chuan, referred with some doubt to this species, differs in having 14 costal grooves; appressed toes overlapping; head width 5 in length from snout to vent; head length 3 in length of body; eye longer than its distance from tip of snout; labial folds less developed; no horny skin on palms and soles (but limbs in poor preservation); tail shorter than body, cylindrical at base, somewhat flattened distally, a dorsal keel on distal third; vomerine teeth 4-5 in series, beginning in from hind edge of nares, running forward and in to level of anterior edge of nares; vent opening at front end of a longitudinal groove, as in male *Hynobius*, this groove does not open into the vent, which is star-shaped, and formed by the confluence of seven grooves. Brownish gray, speckled with black above, and mottled with black below.

In two females, U. S. N. M. Nos. 64419 and 64421, from Mt. Omei the vomerine teeth are as in the described male, running forward and in instead of transversely, but reaching only to the level of the middle of the nares.

In a fourth female, U. S. N. M. No. 10995, a cotype, probably from Moupin, Sze-Chuan, the teeth are transverse as in the specimen first described, but the series is separated from its fellow by one-half its length.

In this connection, Guenther (1896) says "In very young specimens the palatine teeth are placed somewhat differently from the mature condition, and form two oblique series extending beyond the level of the choanae." Bedriaga (1898) figures this condition.

The tail is shorter than the body in four of the five adults I have seen.

The appressed toes touch in No. 10995, and in it the vent is a slit.

A larva, U. S. N. M. No. 64422 from Mt. Omei, has dorsal fin to middle of back; the foot coverings are perfectly distinct; black above, somewhat lighter below.

## MEASUREMENTS.

\* = costal grooves.

/ = costal folds between appressed toes.

Specimen	Locality	Total length	Head	Body	Tail	*	Remarks
U. S. N. M. 10995	(?) Moupin	149	18	66	65	13/0	A Cotype
"	64419 Mt. Omei	141	19	62	60	13/1	
"	64420 "	146	21	55	70	13/1	
"	64421 "	130	15	57	58		
"	64422 " (larva)	39	6.5	15.5	17	13/0	
M. C. Z.	2848 Liang-ho-ko	136	19	59	58	14/0	Tail and color different

The tongue seems to vary considerably, but is usually small and appears retractile into a sheath.

The type shows a somewhat different color: light chocolate; irregular dark mid-dorsal and dorso-lateral streaks, the latter continuing onto tail; mottled with darker below dorso-lateral streak; middorsal area darker chocolate color.

REMARKS: U. S. N. M. No. 10995 was sent from the Paris Museum as a "Type," with the locality "Kiang-si." The types of *Salaman-drella sinensis* having come from Moupin, Sze-Chuan, and there being no other record of this species from Kiang-si, it seems probable that this specimen actually came from Moupin.

M. C. Z. 2848 is in poor preservation, and is the only male I have seen. Hence I am not inclined to lay too much stress upon its peculiarities. But the possibility should be kept in mind that this specimen may belong to another species. It was taken "walking over a bed of damp moss among the stunted spruces and firs at the very limit of tree growth. There was no pond or stream of running water near by." (Barbour 1912.) The appearance of the tail would lead one to suspect less aquatic proclivities than those of the other specimens with their very broad, flat tails.

I doubt very much whether this animal is more allied to *Ranodon* than to *Hynobius*. The peculiar sole modification occurs elsewhere only in *Pachypalaminus boulengeri* of Hondo. The dentition is that of *Ranodon*, but such a weakening of the prevomers might well occur twice.

Unless there are two species included in the above account, there is no close relative, and the animal stands isolated. The occasional resemblance in color to *H. keyserlingii* (seen in the described cotype), the lack of the fifth toe in both, and the fact that *keyserlingii* has

slightly developed labial folds suggest a possible derivation from that species. *Batrachuperus* is an animal of high altitudes and *keyserlingii* is a northern form. There is no known geographical connection between the two at present.

Besides the specimens listed below, it has been recorded from the following places:

Thibet: Province Kham; Kuochu-chin (Guenther 1896).

China: Province Sze-chuan; Sungpan (Guenther 1896); Kzerno River, Lumbu River (Bedriaga 1898).

Specimens seen: 6, as follows;

China: Province Sze-chuan; Moupin 1 (U. S. Nat. Mus. 10995, Cotype) Mt. Omei 4 (U. S. Nat. Mus. 64419-64422) Liang-ho-ko, 12000 feet alt. 1 (M. C. Z. 2848).

NOTE: *Turanomolge mensbieri* Nikolski (1918, Faune de la Russe, p. 256, f. 56, pl. 4, f. 3) described from 61 mm. long larvae collected by V. Nikolski in Russian Turkestan, does not appear to me to be a Hynobiid. It has long series of vomerine teeth posterior to each naris, and no dorsal fin. I suggest that it is the larva of a mountain brook Salamandrid, perhaps allied to *Neuergus crocatus*.

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#### ADDENDA.

##### RANODON SIBIRICUS.

1913. *Ranidens sibiricus* Dorovatovski, Tr. Spb. Obstch. Est., 42, p. 25.

##### ONYCHODACTYLUS FISCHERI.

1912. *Onychodactylus rossicus* Nikolski, Trud. Troitsko-Savsko Kyacht. Otd. Obstch., 15, p. 28. (This may be the original description).





